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0910-LP-012-5410 VOLUME 1

TECHNICAL MANUAL
FOR
SHIPBOARD MODULARITY ARRANGEMENT RECONFIGURATION TECHNOLOGY (SMART) SYSTEM
SMART DESIGN GUIDANCE

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FOREWORD

This manual, Shipboard Modularity Arrangement Reconfiguration Technology (SMART) System, describes the design, installation, and maintenance of the components of the Shipboard Modular Arrangement Reconfiguration Technology (SMART). The designs discussed will enable the ship designer to design or redesign any space onboard US Naval Ships to provide a modular deck foundation track mounting surface. This manual is the primary document for providing guidance for design, installation and maintenance of the SMART components and is designed for use by the Planning Yards, Alteration Installation Teams (AIT), Ship's Force, Shipyards and Shipyard designers. This Manual is divided into three Volumes as listed below:

- Volume 1 - Design Guidance
- Volume 2 - Installation Guidance
- Volume 3 - Maintenance

Eight Technical Notes were developed by the Naval Sea System Command (NAVSEA) during the initial design phase of SMART to document the design process and studies conducted leading up to the existing design. The following is a list of Technical Notes documenting the historical background of SMART development and a short description of each.

a. **Technical Note No. 070-PMS335-TN-0011** C4I Modular Implementation Working Group C4I Modular Track & Fittings Pull Test Report. Describes the pull test performed on the Track and Fittings and the results of the test.

b. **Technical Note No. 070-PMS335-TN-0013** C4I Modular Implementation Working Group C4I Modular Producability Study. Addresses the choices of material for the track, manufacture of the track, surface treatment, track end joints, track lengths, track quantities, manufacture and surface treatment of the fittings, fitting quantities and quantity per system.

c. **Technical Note No. 070-PMS335-TN-0014** C4I Modular Implementation Working Group C4I Modular Foundation Track System Study. Documents the foundation track system various concepts and designs.

d. **Technical Note No. 070-PMS335-TN-0015** C4I Modular Implementation Working Group C4I Modular False Deck Study. Documents the false deck design.

e. **Technical Note No. 070-PMS335-TN-0017** C4I Modular Implementation Working Group C4I Modular Power/IC/Electronics Study. Documents the electrical power, IC, and electronics modular cabling and wiring concepts and designs developed for the SMART components.

f. **Technical Note No. 070-PMS335-TN-0018** C4I Modular Implementation Working Group C4I Modular Foundation Study. Documents the assortment of foundations studied to determine a foundation compatible with the track system.

g. **Technical Note No. 070-PMS335-TN-0019** C4I Modular Implementation Working Group C4I Modular Lighting Study. Documents the lighting concepts and designs developed as potential SMART components.

h. **Technical Note No. 070-PMS335-TN-0020** C4I Modular Implementation Working Group C4I Modular Furniture Study. Documents the modular concepts and designs developed for the modular furniture to be used with the track system.

The SMART system was developed to meet the goals of NAVSEA's Code 03R, Affordability Through Commonality (ATC) program. SMART accomplishes this through modularity, equipment standardization, and process simplification to provide and improve a more efficient installation, assembly, and test of major systems and equipment while reducing the cost of new construction and modernization of US Navy ships

Modularity reconfiguration concepts identified Commercial-Off-The Shelf (COTS) modular components as the means to be more responsive to the fleet's emergent requirements for flexibility in the configuration of shipboard spaces and to provide rapid reconfiguration based on mission requirements. The lack of COTS components currently available to meet all of the shock and loading requirements of combat conditions resulted in the design of the modular components presented in this manual.

The use of modular components makes welding unnecessary, reduces associated cosmetic repairs, minimizes space disruptions, and reduces the amount of installation support.

Volume 2 describes the installation requirements for the modular track system and its components, for existing hull designs, new construction, AIT, and land-based facilities in support of rapid installation and space reconfiguration, under the C4I Shipboard Modular Arrangement Reconfiguration Technology (SMART) program. The application of commercial and rugged modular foundation track is described in this document and includes the selection and installation of all modular equipment and lighting and electrical power distribution components currently developed for installation.

The installation of track, track support structure, deck tile, track cover, and fittings is referred to as the track foundation system. All of these components make up the basic foundation system. The SMART components include a series of workstations accepting Command, Control, Computer, and Intelligence C4I command computers and peripheral hardware of various types and sizes from all branches of the service including NATO.

SMART modular foundation track and components have been installed onboard AGF, LCC and LHA hulls under the design supervision of Puget Sound Naval Ship Shipyard, Detachment Boston (PSNS Det Boston) and Norfolk Naval Shipyard (NNSY). Installation methods and designs are available through both agencies.

Volume 3 describes the use and maintenance of the modular track system and its components. This document provides the necessary information to allow US Naval shipboard personnel to maintain and care for the modular track system, decking, fittings, modular workstations, modular power panels, and modular lighting.

The SMART track foundation system and components are utilized in two phases (Category 1 and Category 2), a track foundation system installation phase and a reconfiguration phase. The category 1 initial installation phase will require traditional services such as welding, shipfitting, wiring, etc. It would most likely be accomplished in a yard period such as initial/new construction, a Complex Overhaul (COH) or a Ship's Restricted Availability (SRA) where the installation of the deck foundation track, subfoundation structure and power panels will occur. At this phase, all of the hot work (welding) will occur. Components such as Operational Space Equipment (OSE) will be installed, as well as modular electrical and lighting system components. At the completion of the initial foundation track installation, the Category I installation will be complete and remains installed for the life of the ship.

The Category 2 installation refers to equipment installations and reconfigurations where virtually no hot work will be required during a complex reconfiguration or installation of new equipment. Equipment will be bolted to the track using the modular fittings and electrical power will be supplied using cables with pre-assembled connector fittings. The ship's crew can accomplish the replacement/removal of deck tiles and hold-down strips without any special tools, adhesives, or coating required, at any time. This second phase use of the SMART track/foundation system provides significant labor cost reduction and minimally disrupts the space.

Ships, training activities, supply points, depots, naval shipyards, and Supervisors of Shipbuilding (SOS) are requested to provide maximum practical use and evaluation of NAVSEA technical manuals. Errors, omissions, discrepancies, and suggestions for improvement to SEAOPS manuals shall be reported to NAVSEA (PMS 335), Washington, DC 20362-5101, in accordance with interim procedures provided in this foreword. Comments may be submitted by message or in NAVSEA Technical Manual Deficiency/Evaluation Report (TMDER) (Form NAVSEA 4160/1). To facilitate such reporting, two copies of NAVSEA Form 4160/1 is included at the end of each technical manual. All feedback comments shall be thoroughly investigated and originators will be advised of action resulting therefrom. Extra copies of Form NAVSEA 4160/1 may be requisitioned from the Naval Publications and Farms Center (NPFC), Philadelphia, PA 19120.

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Chapter 1
Introduction

1-1 General Description

Volume 1 provides design guidance for the ship designer to install the SMART Track System in any appropriate space on board ship. The SMART Track System is a component driven system, with one component relying on another to create an efficient, practical, and structurally sound modular equipment-to-foundation and foundation-to-ship mounting system. The SMART Track System, (which consists of SMART Track support substructure, track, fittings, deck tile and track cover see Figure 1-1), may be installed on top of, or suspended from, any deck within the hull or superstructure. The designer should avoid placing SMART Track on any bulkhead/deck that behaves as hull structure as illustrated in Figure 3-4 of NAVSEA 0908-LP-000-3010, Rev. 1. However, when SMART Track must be placed on bulkheads/decks that behave as hull structure, all static design capacities shall be reduced by half.

1-1.1 Definition of SMART Track

There are four material options for the track: HSLA-80 steel track (type “S”), ordinary strength steel track (type “M”}, 5456-H116/H117 aluminum track (type “A”), and the 7000 series aluminum (type “C”) COTS light-duty (commercial heavy-duty) track for shipboard application. ISO 7166 identifies the center-to-center spacing of the attachment points as 1.000" ± .004" and defines the tolerances of the inside throat surfaces for each type of foundation track. The only dimensional variables between the track types are the cross sectional profiles for each material to meet the load requirements for a hull compatible material. The tracks are spaced 12" apart and held parallel and in pitch within ± .005" (see, Figure 1-2, Figure 1-3, Figure 1-4 and, Figure 1-5.

1-1.2 Deck Applications

The SMART track system provides for rapid space arrangement reconfiguration. The completed system eliminates welding, painting, insulation, and deck surface treatments. Disturbance to adjacent compartments is eliminated. Deck track arrays are arranged twelve inches center to center and may be oriented longitudinally or transverse to the ship centerline.

1-1.3 Bulkhead/Overhead Applications

Modular power and electronics components utilize bulkhead mounted track. The quantity of bulkhead track per installation will vary based on the amount and size of modular/non-modular power panels and terminal boxes to be installed (see Chapter 4 for installation design requirements). Foundations are utilized to mount the panels and other equipment between tracks. Bulkhead track arrays are typically spaced twenty-four inches center to center, and they may be oriented vertically or horizontally. The track and fitting design is also compatible for mounting horizontally in the overhead.

1-2 Weldable Track

The HSLA 80 steel (type “S”), the ordinary strength steel (type “M”), and the 5456 aluminum (type “A”) tracks developed by the Navy are all weldable materials. The basic design for 100% strength (Grade A shock) requires a continuous three-sixteenths fillet weld along each side of the track for the steel materials and a continuous five-sixteenths weld along each side of the track for the aluminum material.

1-2.1 Type “S” Track

High strength (80,000 psi) low alloy HSLA-80 steel was chosen for its high yield stress. The HSLA track shall be manufactured in accordance with NAVSEA drawing 53711-180-6904881, “Steel Foundation Track” (see Figure 1-3). The Type “S” foundation track is designed for welding to a steel subfoundation or steel deck or bulkhead.

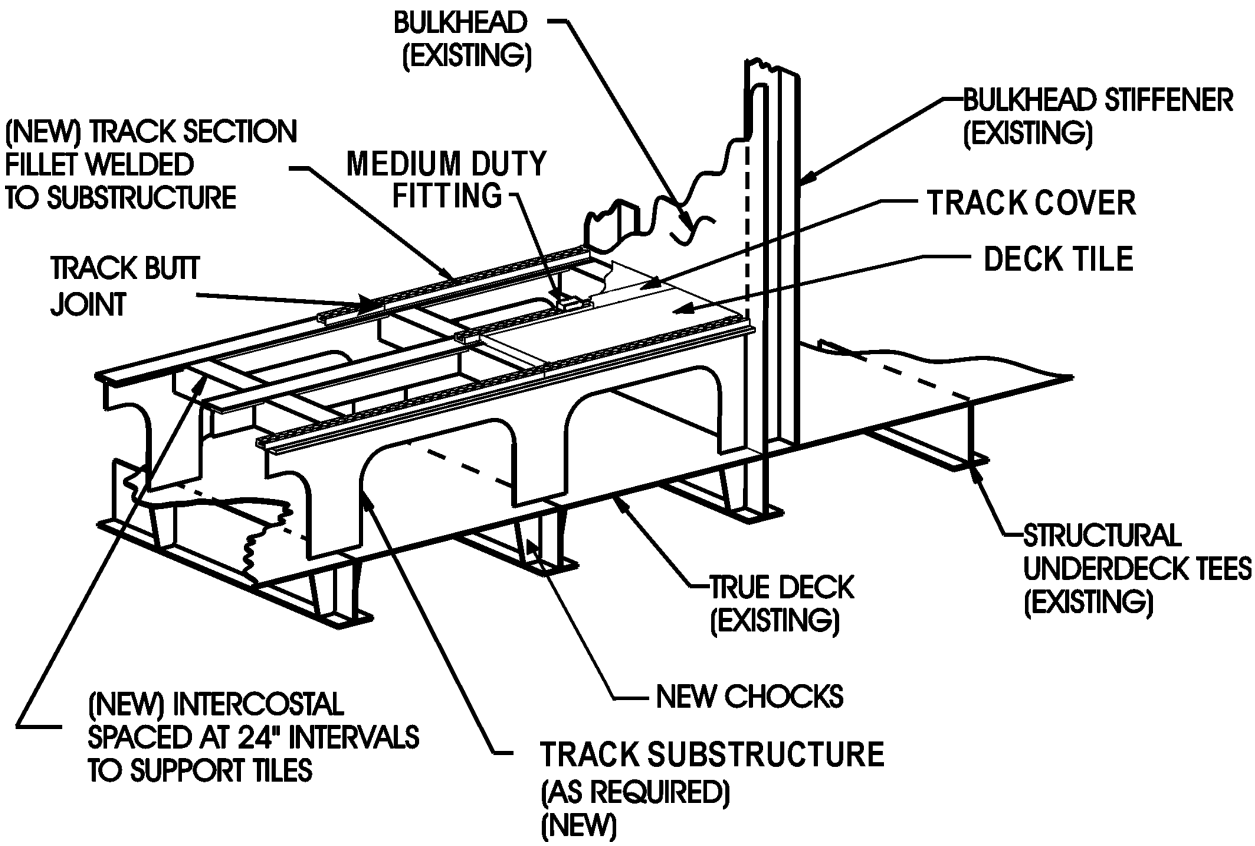


Figure 1-1 Track, Typical Subfoundation

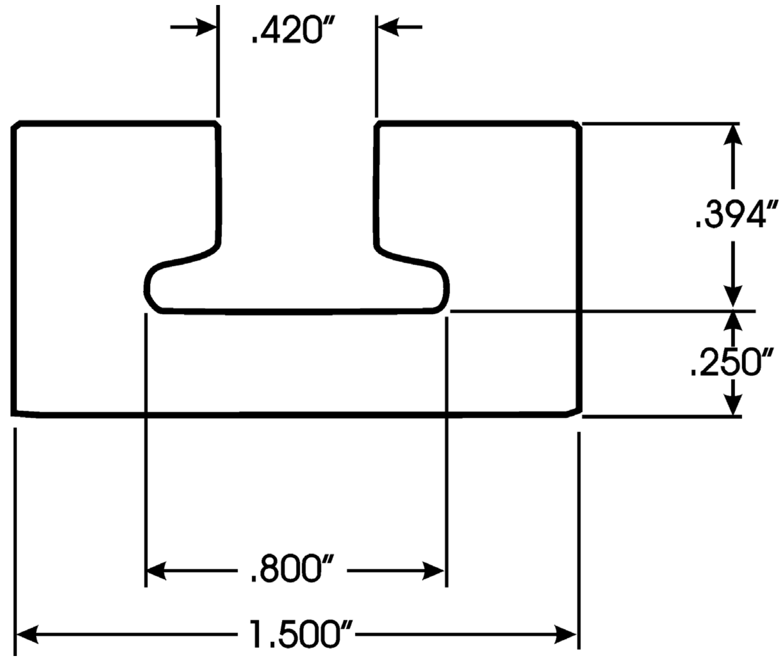


Figure 1-2 Type "S" Track, HSLA 80 Foundation Track HSLA 80 Steel (Weight 2.41 LB/LF)

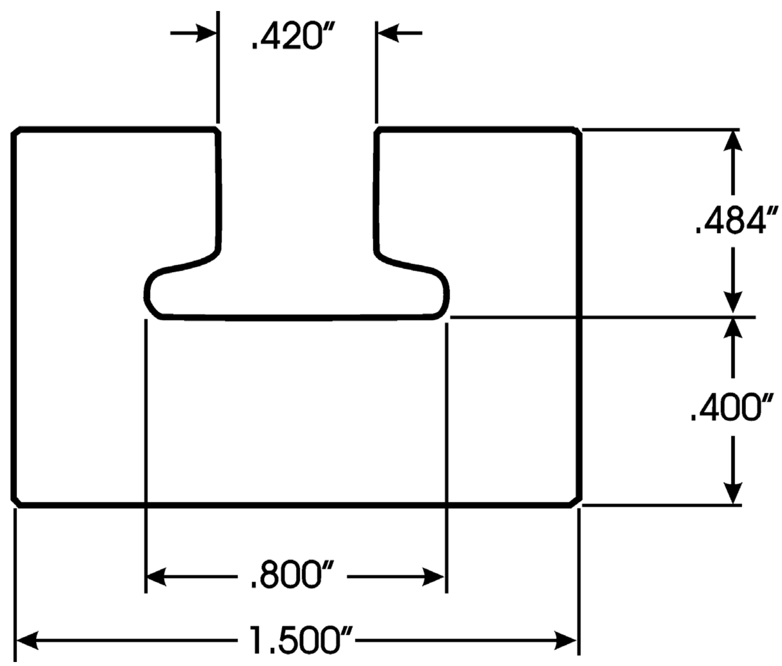


Figure 1-3 Type "M" Track, Steel Foundation Track Ordinary Strength Steel

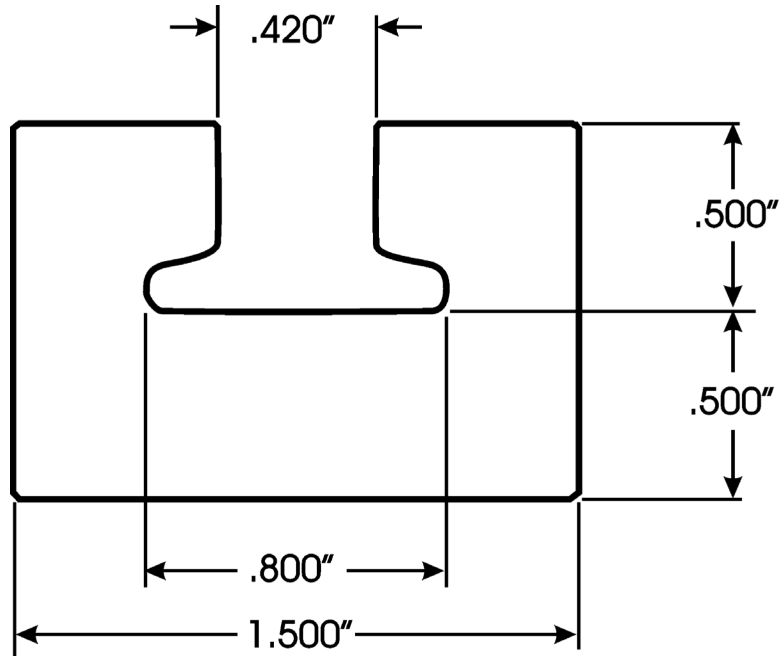


Figure 1-4 Type "A" Track, Aluminum Foundation Track 5456-H116 (Weight 1.43 LB/LF)

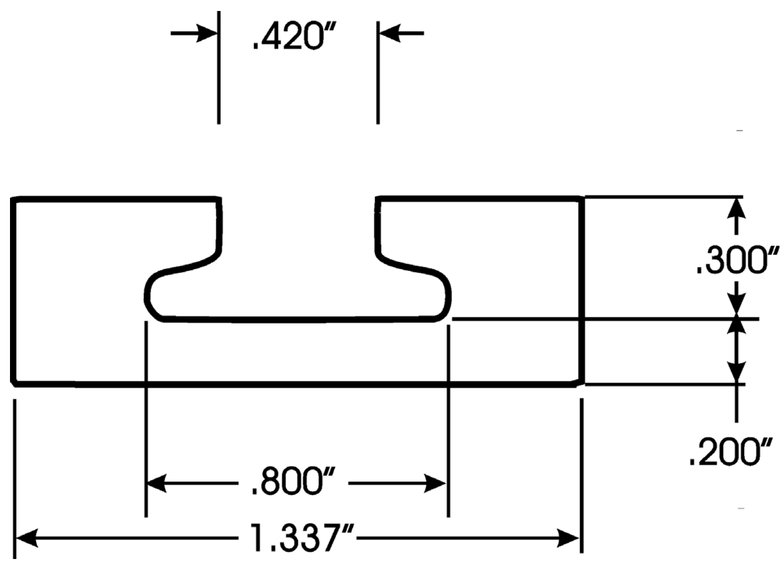


Figure 1-5 Type "C", Commercial Aluminum Track 7000 Series Alum (Weight 0.60 LB/LF)

1-2.2 Type “M” Track

Ordinary strength steel is used for the fabrication of this track. This material has a yield stress of 34,000 psi and was included for economy, availability and reliability. Type “M” track shall be fabricated in accordance with NAVSEA drawing 53711-180-6904881, “Steel Foundation Track” (see Figure 1-3). The Type “M” foundation track is designed for welding to a steel subfoundation or steel deck or bulkhead.

1-2.3 Type “A” Track

The specified material for the Type “A” aluminum track is alloy 5456-H116/H117. This material has a yield strength of 33,000 psi for prime material and 26,000 psi for welded material. The track shall be in accordance with Standard NAVSEA drawing 53711-180-6904880 “Aluminum Foundation Track “ (see Figure 1-4). The Type “A” foundation track is designed for welding to an aluminum subfoundation or aluminum deck or bulkhead.

1-3 Commercial Track (Non-weldable)

A candidate for a mounting system is the COTS aircraft deck track and stud fittings manufactured in accordance with International Organization for Standards (ISO 7166) Aircraft Rail and Stud Configuration for Passenger Equipment and Cargo Restraint. This track is the approved standard and is accepted for use by the FAA and ISO communities. To meet Grade “A” shock requirements, the track installation shall be designed in accordance with the procedures provided in paragraph 5-3 . This track is not suitable for welding. It must be mechanically fastened to its support structure using high strength, flat head, countersunk screws.

1-3.1 Type “C” Track

The commercial "heavy-duty" track is COTS 7000 series aluminum track. This track, originally designed for the aircraft industry, is not suitable for welding. It must be bolted to the substructure with SAE Grade 8 countersunk bolts spaced 2 inches on center, see paragraph 5-2.3). (see Figure 1-5). The only fitting which is approved for use with this track is the light-duty fitting (see Figure 1-6), which limits the track to use in spaces where only lightweight foundations will be required.

1-4 Shock

Each SMART Track System installation shall be designed to meet MIL-S-901D Grade A shock in accordance with NAVSEA 0908-LP-000-3010, Rev. 1, “Shock Design Criteria For Surface Ships”, with shock inputs from DDS 072. A DDAM analysis shall be performed on the track support substructure using NAVSEA 0908-LP-000-3010, Rev. 1, “Shock Design Criteria for Surface Ships”. The design of the track support structure shall take into consideration the load density and population density for the proposed space, (see chapter 4). Proposed and future equipment foundations shall also have a DDAM analysis performed. The results of both DDAM analyses shall demonstrate adequate foundation strength and fittings loads which do not exceed the proof loads shown in Table 1-1, Table 1-2, Table 1-3 and. Table 1-4. These analyses shall require deck mounted inputs only. In addition, combined loading should also be addressed in accordance with paragraph 6-7 and Figure 3-6 and Figure 3-7.

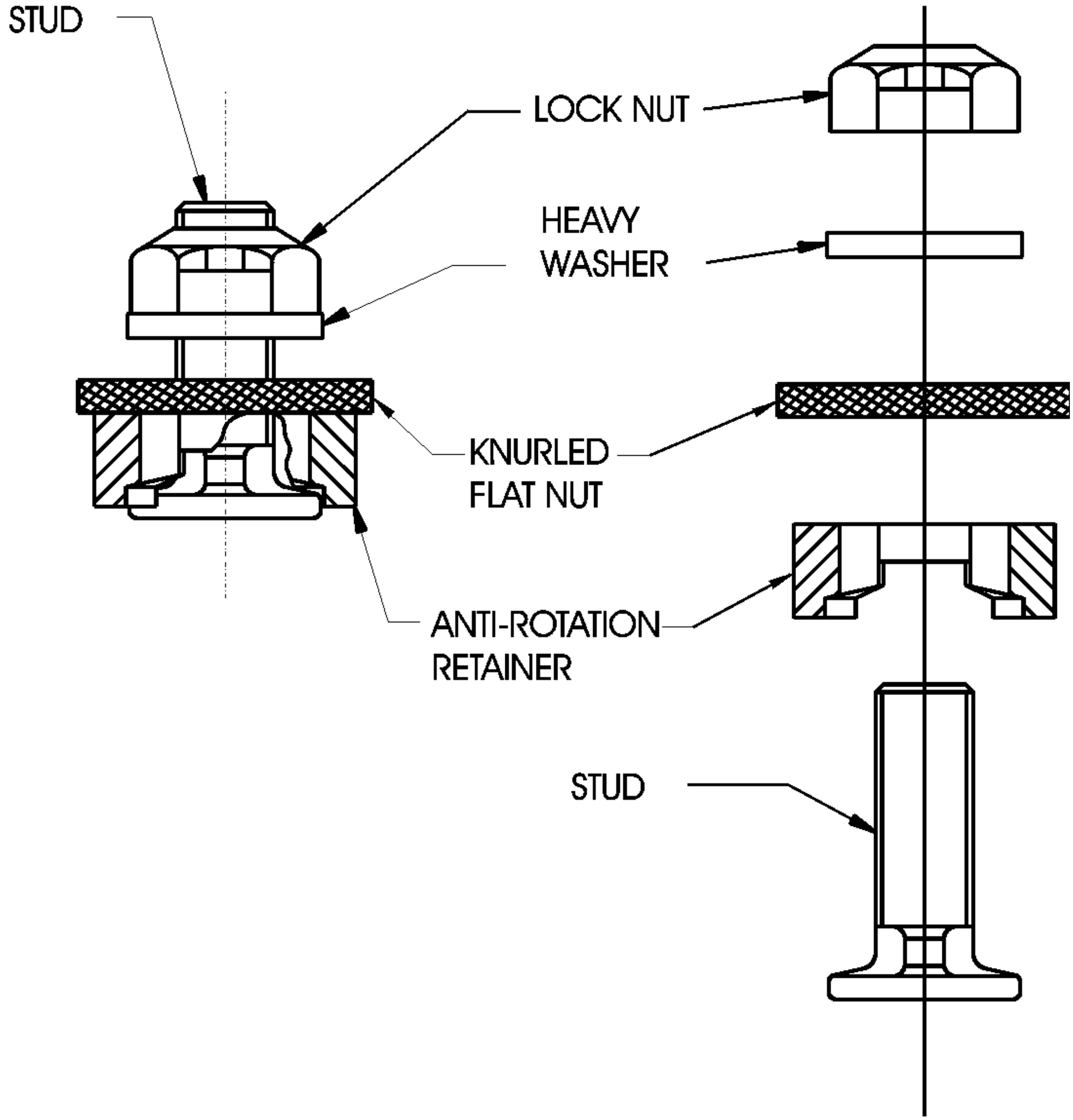


Figure 1-6 Light-duty Fitting shown in Assembled and Exploded Views

*Table 1-1 Proof Loads for HSLA 80 Steel Track** (Type "S")*

FITTING	TRACK	DIRECTION	ULTIMATE LOAD/FTG (LBS)	PROOF LOAD-DECK (LBS)	PROOF LOAD-BHD (LBS)	PROOF MOMENT (IN-LBS)
Light-Duty	HSLA 80	Tensile	11,300	6250	6250	-
	HSLA 80	Shear Across	8543	4167	3333	2470
	HSLA 80	Shear Along	8495	4167	3333	2187
Medium-Duty	HSLA 80	Tensile	21,000	12,500	12,500	-
	HSLA 80	Shear Across	25,190	12,500	12,500	9375
	HSLA 80	Shear Along	28,340*	12,500	12,500	21,875
Heavy-Duty	HSLA 80	Tensile	41,720	25,000	25,000	-
	HSLA 80	Shear Across	30,000*	25,000	25,000	18,750
	HSLA 80	Shear Along	30,000*	25,000	25,000	106,250

***Test machine limit**
****For Combined Loads, see Paragraph 6-7**

*Table 1-2 Proof Loads for OS Steel Track** (Type "M")*

FITTING	TRACK	DIRECTION	ULTIMATE LOAD/FTG (LBS)	PROOF LOAD-DECK (LBS)	PROOF LOAD-BHD (LBS)	PROOF MOMENT (IN-LBS)
Light-Duty	OS	Tensile	11,585	6250	6250	-
	OS	Shear Across	9045	4167	3333	2470
	OS	Shear Along	9050	4167	3333	2187
Medium-Duty	OS	Tensile	23,370	12,500	12,500	-
	OS	Shear Across	21,630	12,500	12,500	9375
	OS	Shear Along	30,000*	12,500	12,500	21,875
Heavy-Duty	OS	Tensile	46,000	25,000	25,000	-
	OS	Shear Across	30,000*	25,000	25,000	18,750
	OS	Shear Along	30,000*	25,000	25,000	106,250

***test machine limit**
****for Combined Loads, see Paragraph 6-7**

*Table 1-3 Proof Loads for 5456-H116 Aluminum Track** (Type "A")*

FITTING	TRACK	DIRECTION	ULTIMATE LOAD/FTG (LBS)	PROOF LOAD-DECK (LBS)	PROOF LOAD-BHD (LBS)	PROOF MOMENT (IN-LBS)
Light-Duty	5456-H116	Tensile	7785	6250	6250	-
	5456-H116	Shear Across	6425	4167	3333	2470
	5456-H116	Shear Along	8425	4167	3333	2187
Medium-Duty	5456-H116	Tensile	15,440	12,500	12,500	-
	5456-H116	Shear Across	19,235	12,500	12,500	9375
	5456-H116	Shear Along	30,005*	12,500	12,500	21,875
Heavy-Duty	5456-H116	Tensile	30,720*	25,000	25,000	-
	5456-H116	Shear Across	30,000*	25,000	25,000	18750
	5456-H116	Shear Along	30,000*	25,000	25,000	106,250

***Test machine limit**
****For Combined Loads, see Paragraph 6-7**

Table 1-4 Proof Loads for COTS Aluminum Track, (Type "C")*

FITTING	TRACK	DIRECTION	ULTIMATE LOAD/FTG (LBS)	PROOF LOAD-DECK (LBS)	PROOF LOAD-BHD (LBS)	PROOF MOMENT (IN-LBS)
Light-Duty	COTS	Tensile	7605	6250	6250	-
Light-Duty	COTS	Shear Across	7675	4167	3333	2470
Light-Duty	COTS	Shear Along	8800	4167	3333	2187

*** For Combined Loads, see Paragraph 6-7**

Chapter 2
Component Description

2-1 Track

The SMART Track System works in conjunction with the fittings to provide a universal bolted modular mounting system. Paragraphs 1-2.1 , 1-2.2 , 1-2.3 & 1-3.1 define the four types of track certified for use within the system. The Type “S”, Type “M” and Type “A” foundation tracks are designed to work with the fittings described below. The Type "C" foundation track is designed to work only in conjunction with the light-duty fitting.

2-2 Track Fittings

The fittings provide a wide range of flexibility. The primary function of the track fittings is to take high-density foundation point loads and distribute them along a foundation track, which has low strength density. The maximum allowable load density along the track is 50 lbs/in, regardless of the fitting or track being used. Actual fitting loads shall be determined by performing a DDAM analysis. All fittings are connected to the track via one or more Track Studs (see Figure 3-6).

2-2.1 Light-duty Fitting

Figure 1-6 is a depiction of the light-duty fitting assembly. The studs for this fitting come in three lengths, 1.5, 1.6, and 1.7 inches. This fitting consists of five parts, the Track Stud, the anti-rotation shear block, the knurled nut, , a flat washer, and a lock nut. The knurled nut holds the fitting to the track and the equipment or foundation is attached to the fitting with the flat washer and the lock nut. The working load of this light-duty fitting is 75 lbs. in tension and 50 lbs. in shear when used on the deck. The shear capability must be reduced to 40 lbs. when this fitting is used on a bulkhead.

2-2.2 Medium-duty Fitting

Figure 2-1 and Figure 2-2 depict the medium-duty fitting. Each medium-duty fitting is secured to the track with two Track Studs and two lock nuts and washers which are supplied with the fitting. The equipment or foundation is attached to the medium-duty fitting with a flat washer and a “foundation mounting bolt” or capscrew. The medium-duty fitting distributes the foundation bolt load evenly over approximately 3.5 inches of track. The nominal working static load of the medium-duty fitting is 175 lbs. in tension and in shear. It should be noted that both the foundation mounting bolt and the track studs are completely protected from shear by the medium-duty fitting block.

2-3 Deck Filler System

The deck filler system is a three part system consisting of a deck tile, a foundation track cover, and, for type “S”, “M” or “A” track, a shim. The deck filler system employs a snap-in foundation track cover used to secure the deck tiles between the track and cover unused portions of the track. The foundation track cover, in conjunction with the tile, creates a seamless deck panel/tile surface that is electrically insulated, easily cleaned, and aesthetically pleasing.

2-3.1 Deck Tile

The deck tile is designed to fit between the tracks and is held in place by the foundation track cover. The strength of lightweight tiles comes from their honeycomb core. The honeycomb core is covered with a fire rated, abrasion resistant plastic laminate (top and bottom). A phenolic strip is bonded around the perimeter of the tile to strengthen, protect, and seal the edges (see Figure 2-6).

2-3.2 Heavy-duty Fitting

Figure 2-3, Figure 2-4 and Figure 2-5 show the heavy-duty fitting for a static working load of 350 lbs. in tension and in shear. The heavy-duty fitting is secured by two medium-duty fittings, which are, in turn secured to the track by two studs each. The heavy-duty fitting distributes the load over approximately 7.00 inches of track.

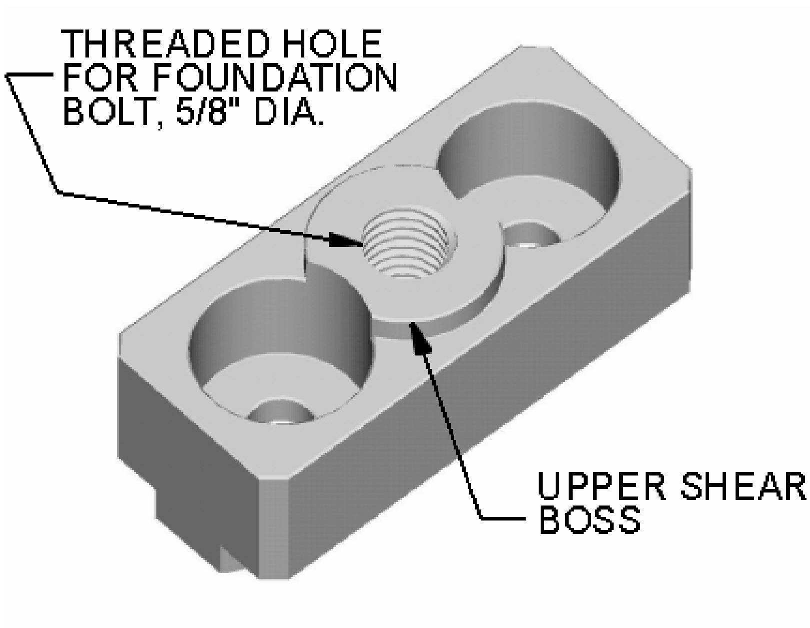


Figure 2-1 Medium-Duty Fitting Isometric View showing Upper Shear Boss Two Studs, with Prevailing Torque Nuts and Flat Washers are required to Secure the Fitting to the Track. This Fitting CANNOT be used with COTS Track.

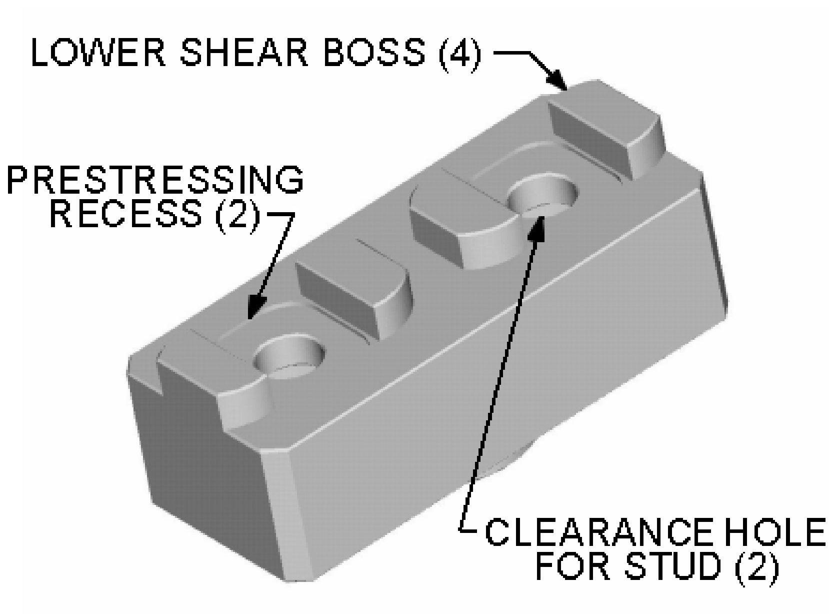


Figure 2-2 Medium-Duty Fitting, Bottom Surface showing Lower Shear Bosses and Prestressing Recesses

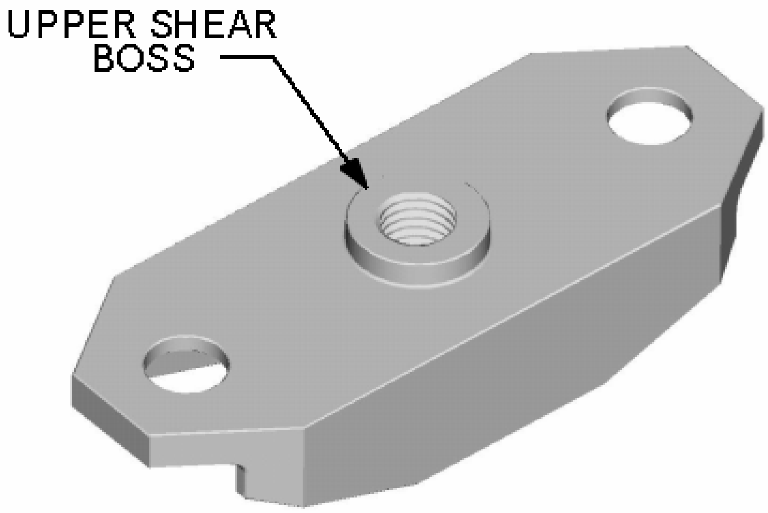


Figure 2-3 Heavy-duty Fitting Top View showing Foundation Shear Boss

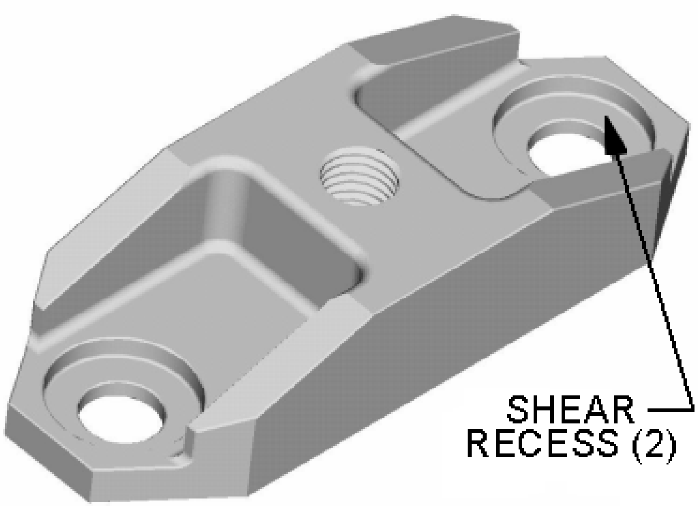


Figure 2-4 Heavy-duty Fitting, Bottom View Showing Shear Recess for Medium-duty Fittings

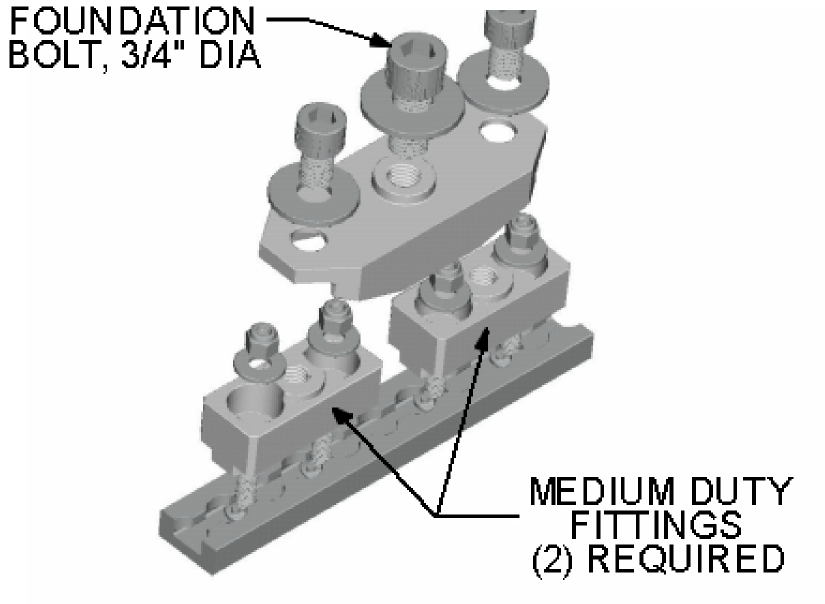


Figure 2-5 Exploded View of Heavy-duty Fitting Assembly

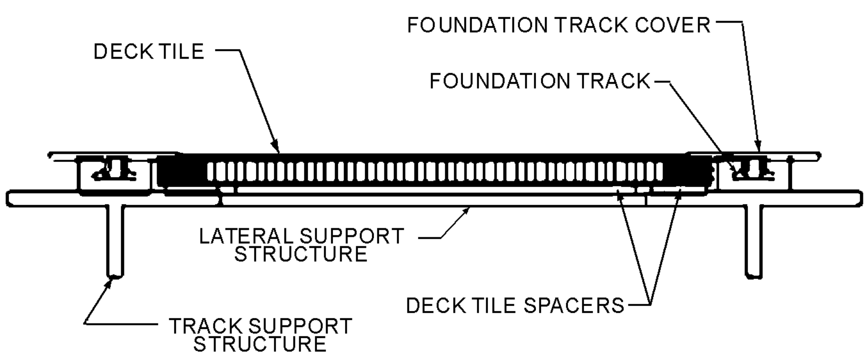


Figure 2-6 Deck Tile Assembly showing Tile Spacer and Track Cover Usage

2-3.3 Track Cover

The foundation track covers are designed to snap into the track. The track throat depth cross-sectional profile varies for each type of track; therefore, a different track cover is required for each style of track (see Figure 2-8, Figure 2-9 and Figure 2-7).

2-3.4 Shims

Shims are required when a type “S”, type “M” or type “A” foundation track system is installed to bring the deck tiles up to the correct level so that the foundation track covers will work properly and provide a smooth deck. The type "C" track does not require shimming the deck tile. The tiles come from the manufacturer with the shims installed. Tiles that are cut on site for installation will require that shims be installed so that the deck filler system functions properly.

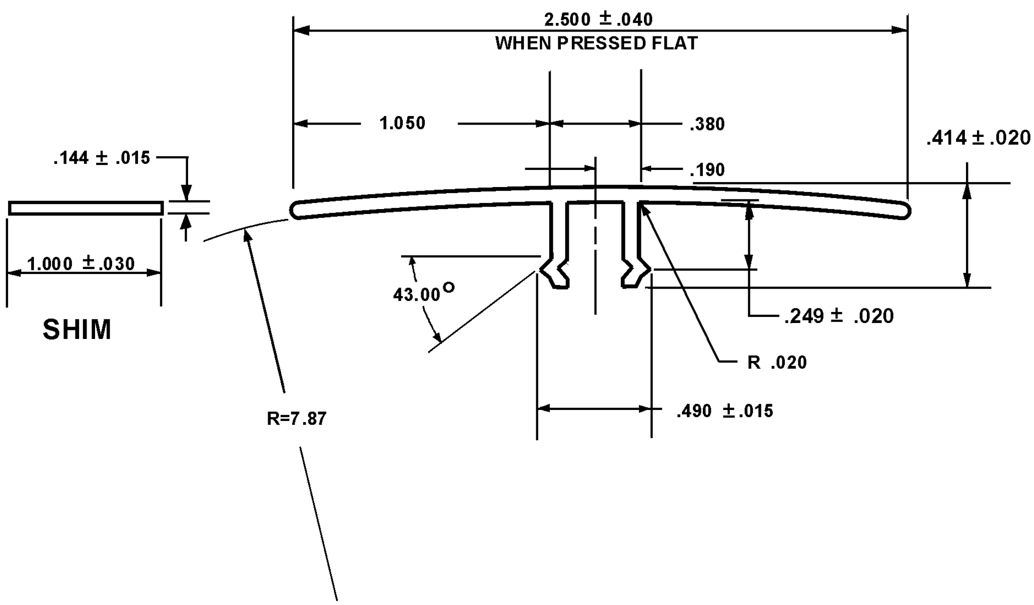


Figure 2-7 Track Cover and Shim for Type “S” Track

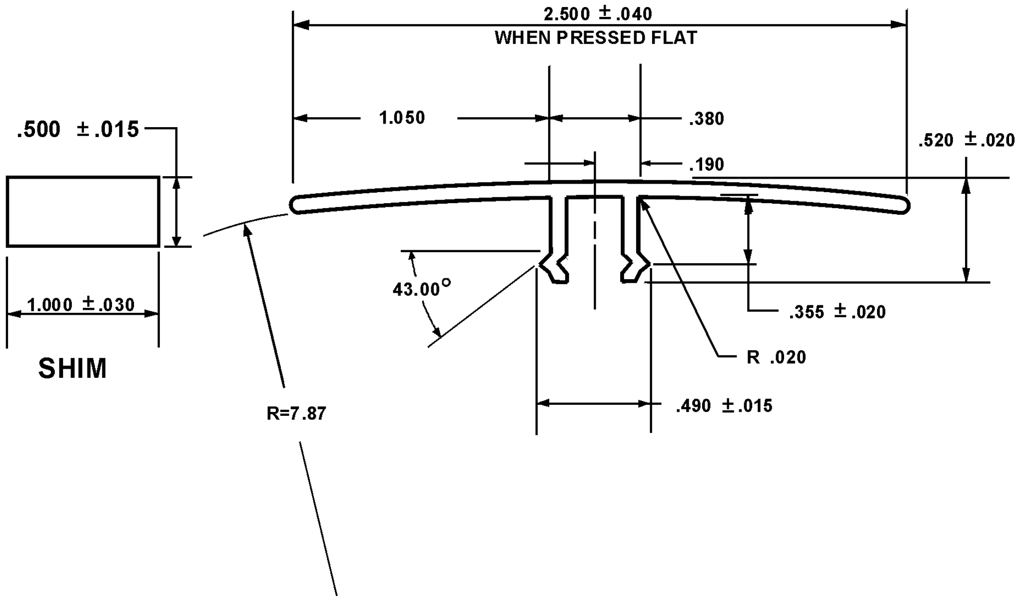


Figure 2-8 Track Cover and Shim for Type "M" Track. Type "A" Track uses the same Track Cover

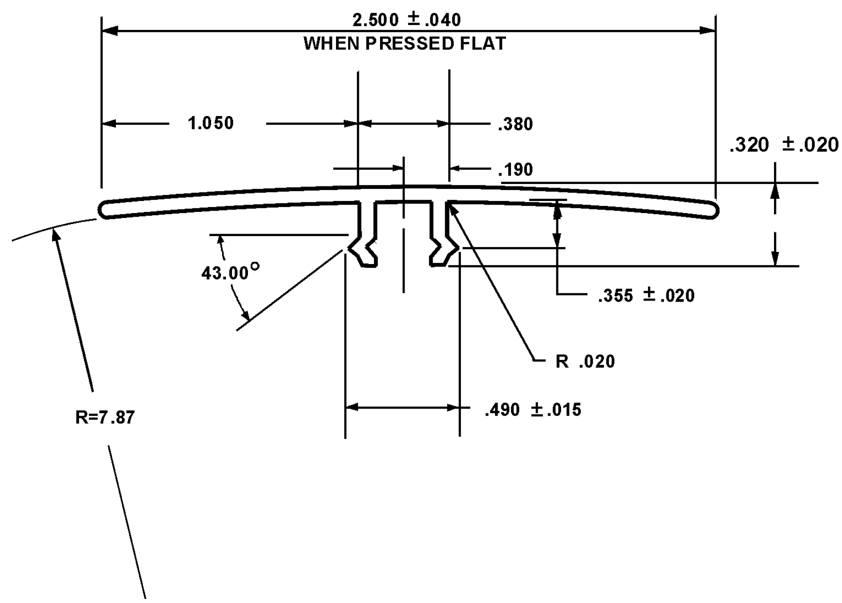


Figure 2-9 Track Cover for Type "C" Track. No spacer is needed for this track

2-4 Equipment Foundation

The equipment foundation provides for equipment to track mounting, allowing for equipment that was not designed for SMART track installation to be mounted to the deck foundation track. The design engineer shall design the equipment foundation in accordance with NAVSEA 0908-LP-000-3010 “Shock Design Criteria for Surface Ships”, with shock inputs from DDS 072. The results of a DDAM analysis shall demonstrate adequate foundation strength and fitting loads which do not exceed the proof loads shown in Table 1-1, Table 1-2,Table 1-3, AND Table 1-4. In addition, combined loading should also be addressed in accordance with paragraph 6-7 and Figure 3-6 and Figure 3-7. The foundation shall provide compatible mounting holes for both the track and equipment. See Figure 2-10 for an example.

2-4.1 Equipment Mounting

The equipment foundation will be unique for each equipment. Each foundation is designed to interface with a specific equipment footprint. The equipment foundation takes into consideration the fact that no two items have the same weight or dimensional footprint. The equipment foundation design may then become a standard NAVSEA drawing for all other SMART applications for the same piece of equipment. The structurally designed equipment foundation may be drilled for specific track spacing around the base perimeter. Appropriate attachment fittings must be ordered with the foundation.

2-5 SMART System Special Support Equipment

2-5.1 Foundation Track Installation Kit

The foundation track installation kit is designed to establish the initial installation reference plane around the perimeter of the space, align the foundation track in straight parallel rows, and provide proper hole pitch and spacing of track end joints. The track installation kit consists of two jigs with lasers matched to each jig, two targets, and two drill guides. Although the jig is an item used in the alignment of the foundation track installation, it performs the crucial functions of securing the track in place for tack welding of Types “S”, “M” and “A” foundation track. The twelve-inch track jig is utilized to maintain tight, but obtainable tolerances for the installation of deck foundation track, to a subfoundation or true deck (see Figure 2-11). The twenty-four-inch track jig is designed to install bulkhead mounted track to a lesser degree of tolerance within a specified range (see paragraph 4-4.2.2).

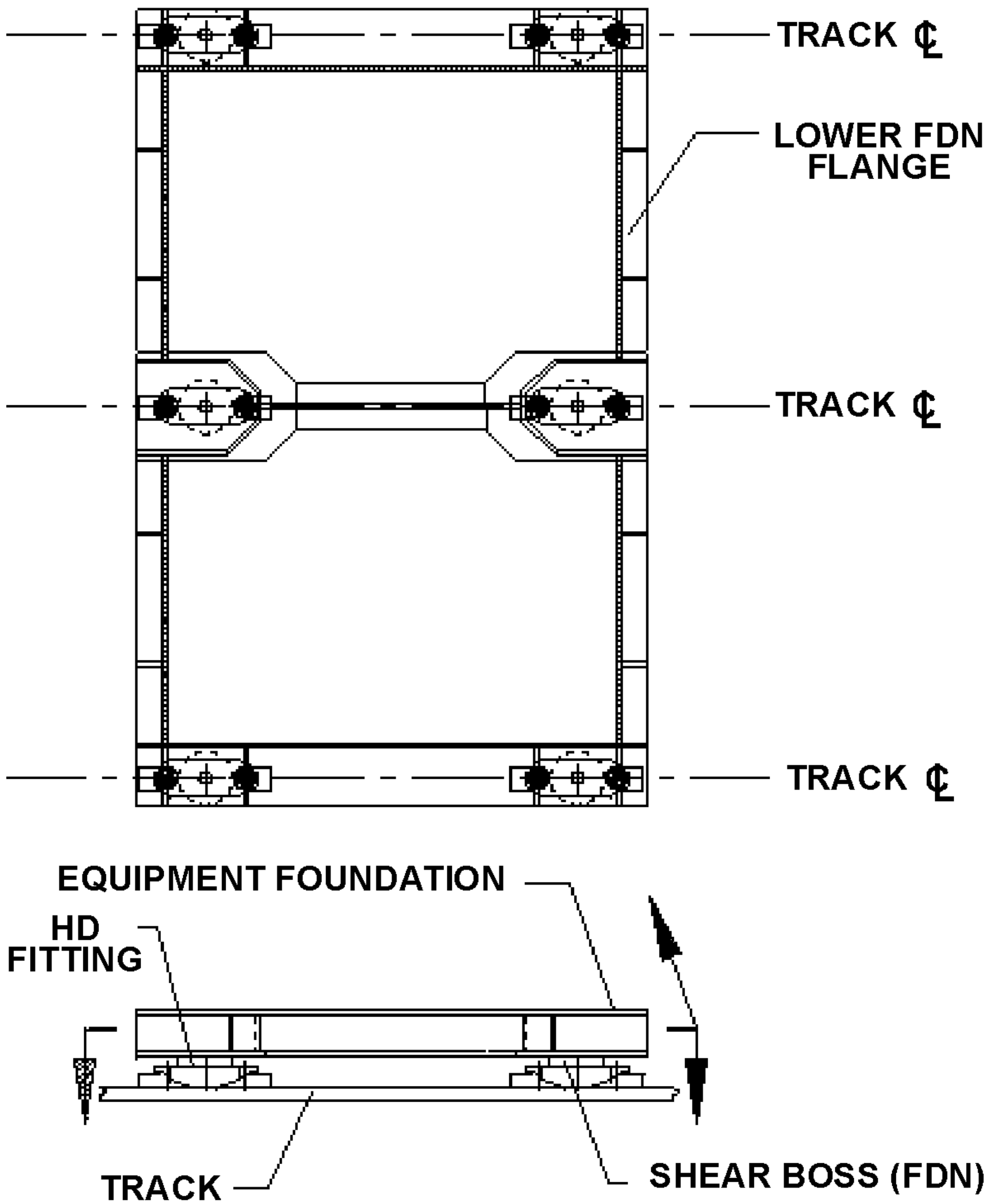


Figure 2-10 Typical Foundation on Heavy-duty Fittings

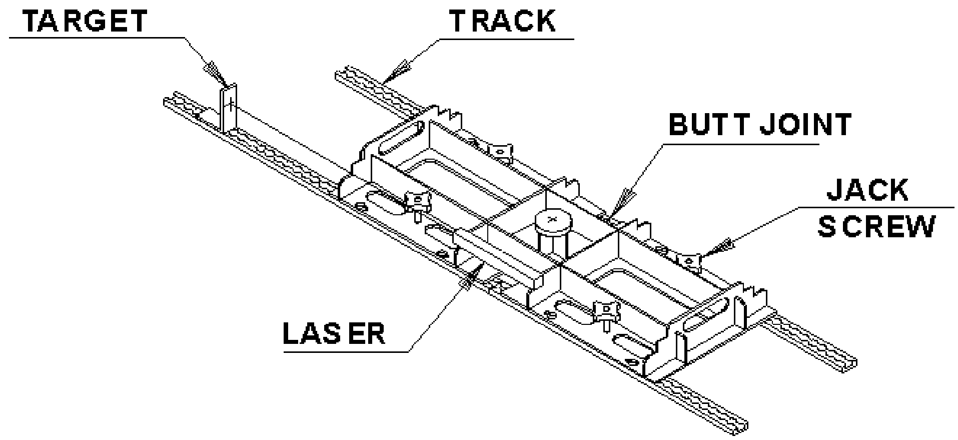


Figure 2-11 Installation Jig showing Laser & Target Setup for Track Alignment

Chapter 3
Component Design Criteria

3-1 Introduction
This chapter provides guidance to the design activity in selecting the appropriate SMART Track System components.

3-2 System Parameter Development (Background Information)

3-2.1 System Capacity Rationale
The goal of the SMART System is to provide an economical system that allows easy and rapid removal and installation of equipment and foundations in C4I spaces. Parameters have been established in order to determine reasonable maximum design loads and geometric arrangements for the system.

The heaviest practical piece of C4I equipment considered as a candidate for reconfiguration is a fully loaded heavy-duty electronic equipment enclosure (see Figure 3-1). The critical design loading conditions for the modular track system were determined from the shock forces acting in the three principle directions through the geometric center of gravity of this representational enclosure. Shock forces were computed using NAVSEA 0908-LP-000-3010, Rev. 1 using inputs from DDS 072-1.

The maximum total weight (rack and contents) of the representational enclosure used is 1690 lbs. over a four square foot area. The sample deck chosen for the design calculation was from the superstructure of an LPD 4 Class ship.

3-2.2 Shock Acceleration Parameters
Using the system capacity parameters from paragraph 3-2.1 the shock accelerations were computed as follows:

Vertical: 59.2g's

Longitudinal: 11.8g's

Transverse: 23.7g's

3-2.3 Computed Reactions (see Figure 3-1)
The reactions at each support point of the representational enclosure that would produce the critical fitting stresses are computed by applying the shock accelerations to the geometric center of gravity of the representational enclosure while it is restrained by four of the proposed fittings arranged in a twelve-inch by twelve-inch grid.

The following definitions were used in the calculation:

F = Vertical force per fitting or per support point

R = Vertical force at each of the four support studs

S = Shear load at each of the four support studs

3-2.3.1 Vertical Shock Computed Reactions (see Figure 3-2)
F = (59.2g)(1,690 lbs.)/4 = 25,000 lbs. Fitting Load

R = 25,000 lbs./4 = 6,250 lbs./Stud

The above results indicate the requirement for a fastener with a 25,000 pound capacity. This became the governing design point in the search through industrial and commercial fastening systems to determine if an existing system would be suitable for use on Naval ships.

3-2.3.2 Transverse Shock Computed Reaction – (Unbraced Weight)

In order to determine when upper foundations are required it is necessary to determine how much weight could be supported in the representational enclosure at the geometric cg in the transverse direction. For a maximum unbraced weight load diagram see (Figure 3-3).

Max Unbraced Weight = (25,000 lbs.)(2)(12 in.)/(23.7 g)(41 in.) = 617 lbs.

R = 25,000 lbs./4 = 6,250 lbs.

S = (617 lbs.)(23.7)/(4)(4) = 914 lbs.

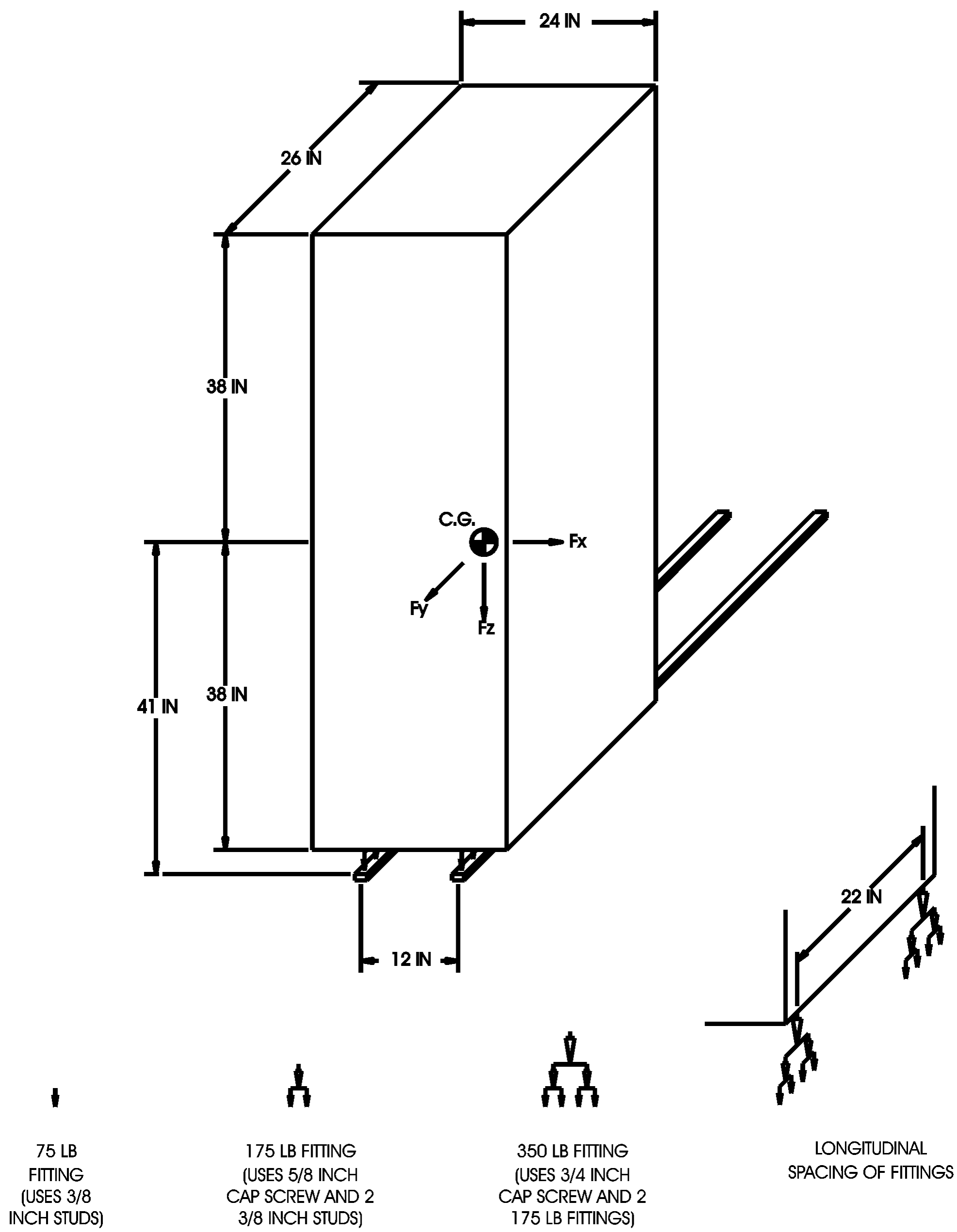


Figure 3-1 Point Loading Diagram

3-2.3.3 Longitudinal Shock Computed Reaction

F = (617 lbs.)(11.8)(41 in.)/(22 in.)(2) = 6,784 lbs.

R = 6,784 lbs./4 = 1,696 lbs.

S = (617 lbs.)(11.8)/(4)(4) = 454 lbs.

These results indicate that the longitudinal shock reaction does not control the upper foundation requirement.

3-2.4 Conclusion

A fitting with a maximum dynamic point load capability of 25,000 lbs. and a nominal working load of 350 lbs. is suitable for this representational enclosure.

3-2.5 Aircraft System Modified For Shipboard Use

A search through existing industrial and military fastening systems led to the universally used aircraft seat track and its attachment stud. The aircraft hardware has a worldwide ISO standard that defines component geometry. The strength rating for the aircraft components is close to the requirements for a Navy shipboard system. The aircraft track, however, is fabricated from 7000 series aluminum that is not suitable for welding (see Figure 1-5 and Figure 3-4).

Aircraft system components and prototype Navy components were tested to destruction and the results indicated that a system that would meet Navy requirements could be designed using these concepts. SMART studs and new track profiles were developed which meet the goals for strength, ship fabrication and utility for successful Navy use.

Table 3-1 Stud Length Selection

Track Type	Stud Length
Type “S”	1.6 Inches
Type “M”	1.7 Inches
Type “A”	1.7 Inches
Type "C"	1.5 Inches

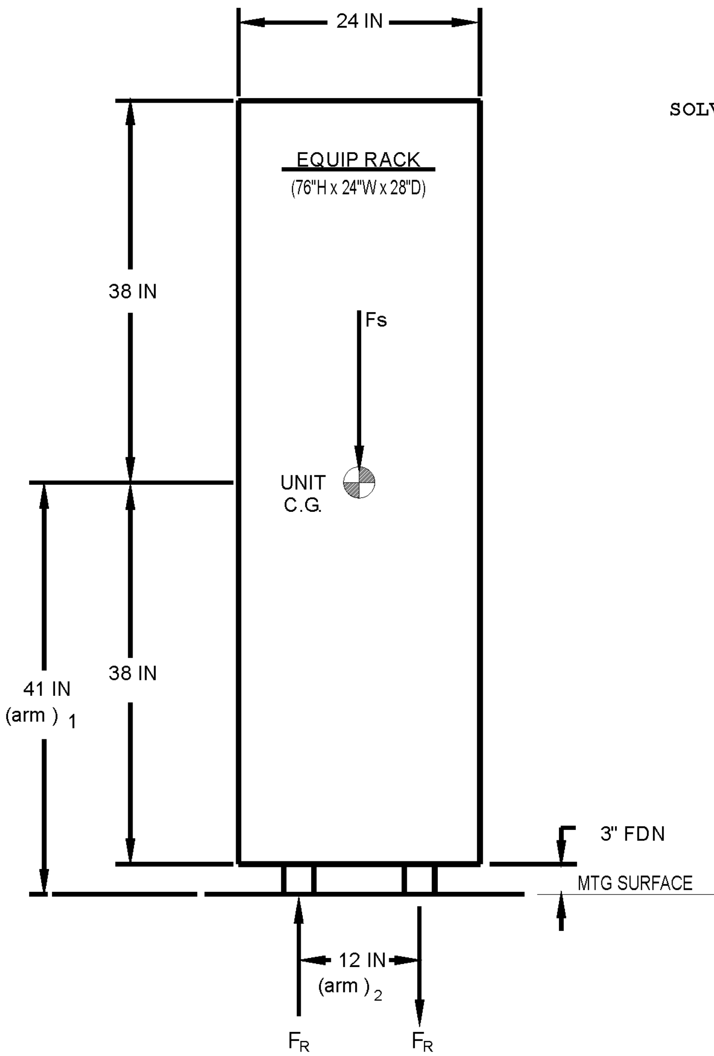
3-3 Mechanics of the SMART Track System

The SMART Track System performs the function of transmitting equipment restraint loads to the ship structure. The track is mounted either directly to the deck or is mounted on a substructure which is attached to the deck (see Figure 1-1). The SMART track system and components are utilized in two phases, the initial installation phase and the reconfiguration phase.

The initial installation phase is where the installation of the SMART Track System will occur. This phase will require traditional services such as welding, shipfitting, etc. It is most likely to be accomplished in a yard period such as new construction, a Complex Overhaul (COH) or a Ship’s Restricted Availability (SRA).

The reconfiguration phase refers to equipment installations and reconfigurations where virtually no welding will be required during the reconfiguration or installation of new equipment in a space previously equipped with the SMART Track System. Equipment will be bolted to the track using the SMART system fittings and pre-fabricated foundations.

HEAVY DUTY FITTING DESIGN STRENGTH
VERTICAL FORCE



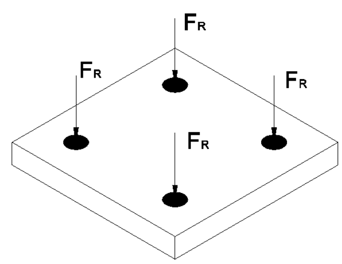
W =max allowable weight
without sway bracing

SOLVE FOR W:

A_O =shock acceleration value for
deck mounting locations

Ao(vert) = 59.2g's

F_R =design loading of fitting
=25 kips = 25,000 lbs



F_S =allowable shock force
$\leqq 4F_R$ = 100 kips

F_S =A (vert) x W = 100,000 lbs
=(59.2) x W = 100,000 lbs

W (max) = 1690 lbs

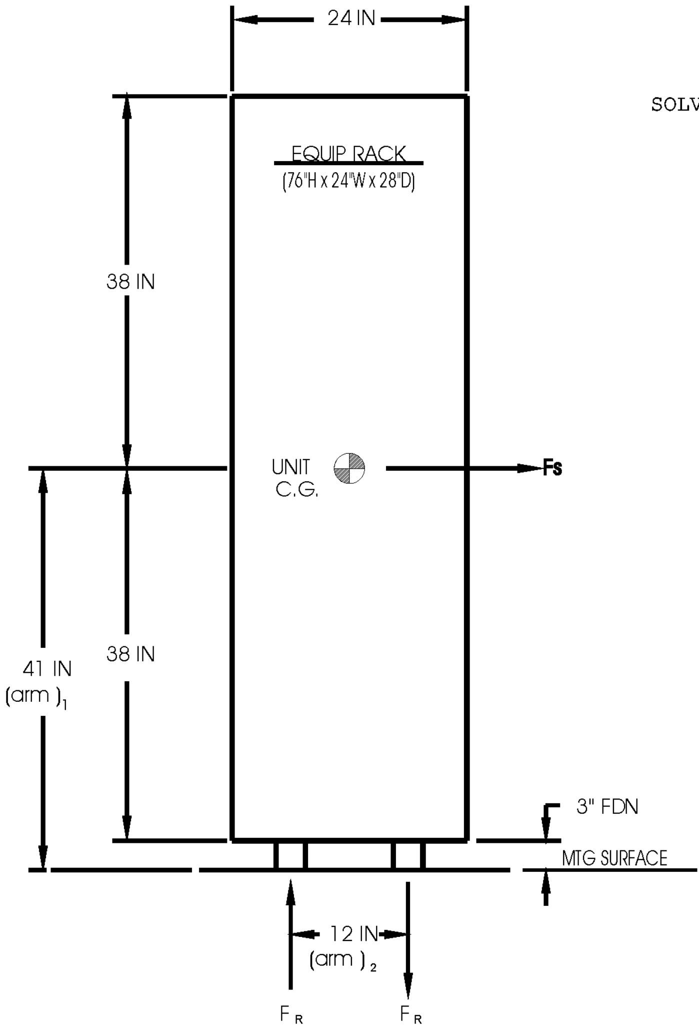
NOTE: ADDITIONAL FITTINGS MAY BE UTILIZED
AS REQUIRED FOR WEIGHTS GREATER
THAN 1690 lbs.

ELEV VIEW

RACK FRONT
STANDARD 19" HEAVY DUTY RACK

Figure 3-2 Load Conditions Vertical Shock

HEAVY DUTY
HEAVY DUTY FITTING DESIGN STRENGTH
OVERTURNING FORCE



ELEV VIEW

RACK FRONT
STANDARD 19" HEAVY DUTY RACK

W =max allowable weight without sway bracing

SOLVE FOR W:

A_O =shock acceleration value for deck mounting locations

Ao(vert) = 59.2g's
Ao(athw) = 23.7g's

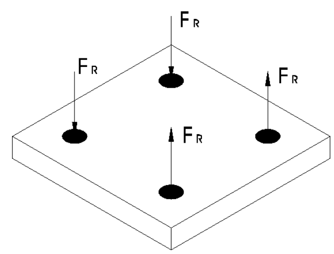
F_S =shock force
=Ao(athw) x W
=(23.7 x W)

M_S =overturning moment due to shock
=Fs x arm $_1$ = (Fs)(41") = (23.7W x 41")
=971.7W

M_R =resisting moment required to restrain overturning moment

F_R =resisting force of deck fittings
=25,000 lbs

a foundation is made up of two sets of fittings so the system can support $2F_R$



$2F_R$ = 50,000 lbs = M_R / arm $_2$
= 50,000 lbs = 971.7 (W) / 12

W (max) = 617.5 lbs

Figure 3-3 Loading Condition Athwartships Shock

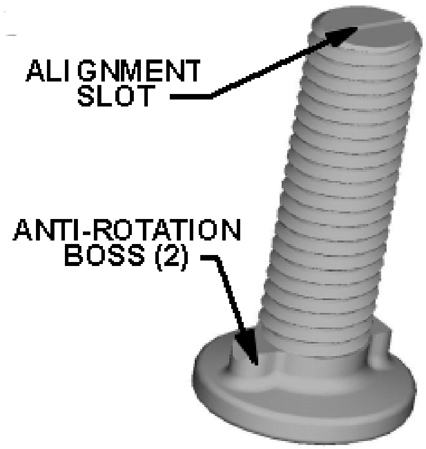


Figure 3-4 Coarse Thread SMART Track Stud showing Alignment Slot at the Top and Anti-Rotation Bosses at the Bottom

3-3.1 Basic Function of the SMART Track System

3-3.1.1 Basic Function of the Track

The basic function of the SMART Track System is to provide a durable, shock capable mounting platform for equipment and modular components. The track allows equipment to be quickly and easily installed, removed, and/or relocated without any welding, painting or other disruption to the ship structure. The finished look of the deck is restored by rearranging the deck tiles and hold down strips.

The track seat flange inside surface will support upward loading, while downward loading is supported by its top surface (see Figure 3-5, Figure 3-6 and Figure 3-7). The track seat cantilever pairs are designed to exceed the designed shear load capability of the holding stud when stressed to failure. The Type “S”, “M”, “A” and "C" tracks are designed to carry the load at any seat along the track including the ends. Track studs shall never be placed in adjacent seats, however. The track is designed for the maximum stud placement to be in every other hole.

The spacing between the track centers shall be twelve inches. The track types “S”, “M” and “A” shall be welded to the substructure or deck. Track type "C" shall be bolted to substructure.

3-3.1.2 Basic Function of the Light-duty Fitting

The light-duty fitting is essentially a nut and bolt securing device, subject to tension and shear, transmitting those forces to the hull via the track. Designs utilizing light-duty fittings shall be restricted to a minimum of eight inches between fitting centers that are used on the same foundation. The light-duty fitting may be used with type “S”, “M”, “A” or “C” track (see Figure 1-6).

3-3.1.3 Basic Function of the Medium-duty Fitting

The medium-duty fitting is a point load distribution device for taking a concentrated foundation load and distributing it evenly between two foundation track studs along the track. A single medium-duty fitting has the essential capacity of two light-duty fittings, however, two light-duty fittings shall **not** be used in lieu of a single medium-duty fitting. Designs utilizing medium-duty fittings shall include a minimum of eight inches between fitting centers on the same foundation. This fitting may be used only with types “S”, “M” and “A” track (see Figure 2-1, Figure 2-2, Figure 3-6, and Figure 3-7).

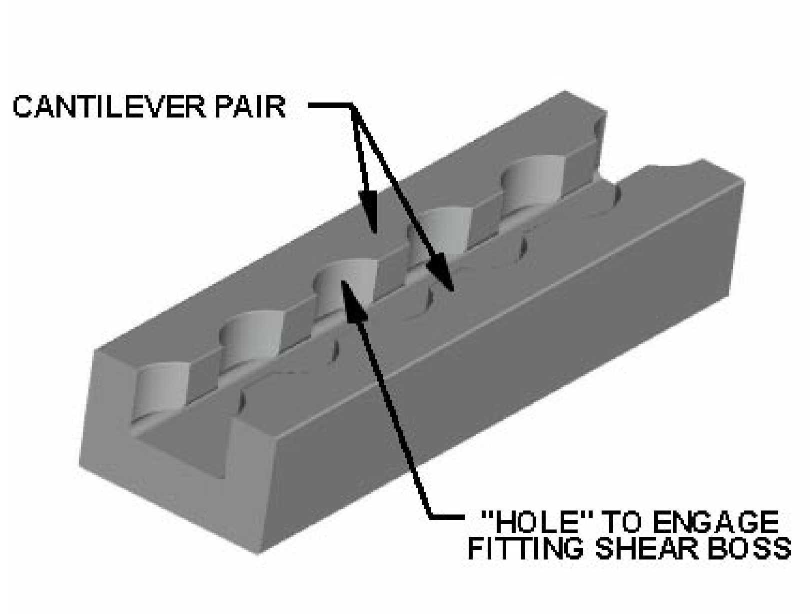


Figure 3-5 SMART Track (OS Shown) Showing Alternate Cantilever Pairs and Holes

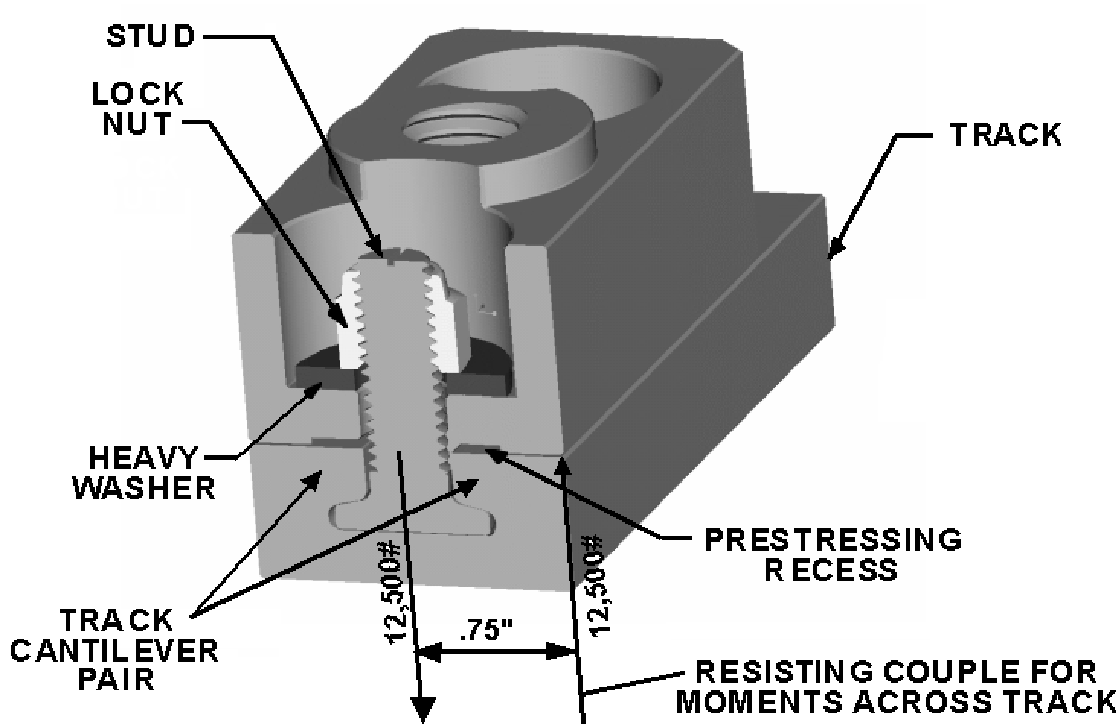


Figure 3-6 Cut-Away View of Medium-Duty Fitting showing Stud Interaction with Track Cantilevers

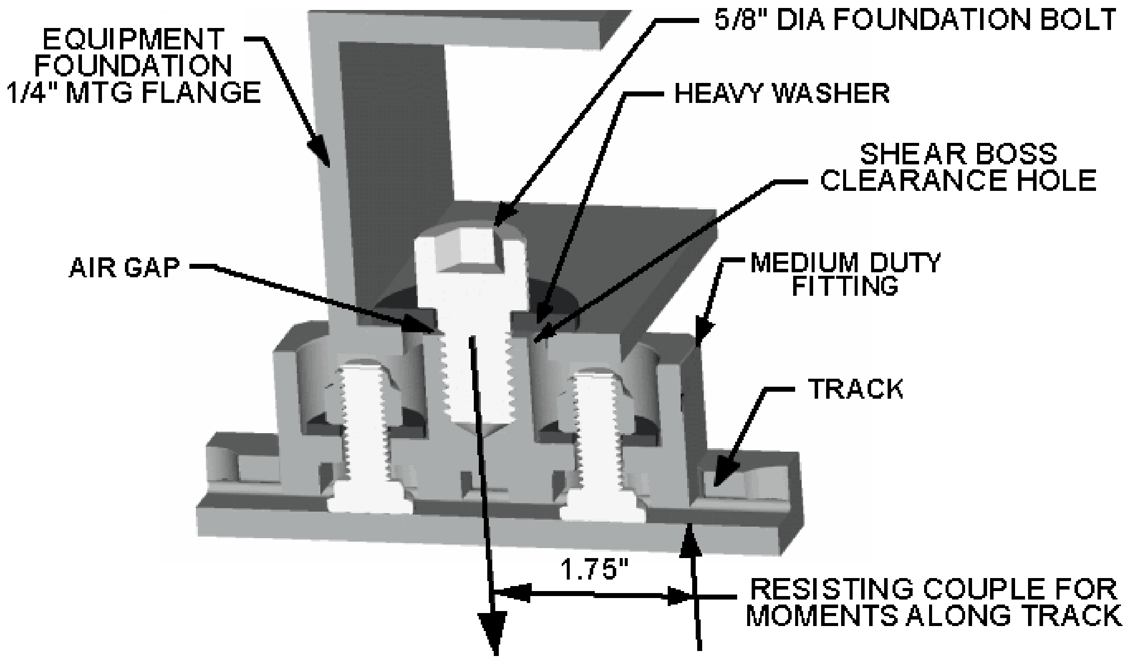


Figure 3-7 Cut-Away View of Medium-Duty Fitting showing Foundation Mounting Bolt "Clamping" the Foundation Over the Upper Shear Boss

Basic Function of the Heavy-duty Fitting

The heavy-duty fitting is a point load distribution device for taking a concentrated foundation load and distributing it evenly between two medium-duty fittings along the track. A single heavy-duty fitting has the capacity of two medium-duty fittings, however, two medium-duty fittings shall **not** be used in lieu of a single heavy-duty fitting. Designs utilizing heavy-duty fittings have no minimum spacing requirement. This fitting may be used only with track types “S”, “M” and “A” (see Figure 2-3, Figure 2-4, and Figure 2-5).

3-3.2 Fitting Details

3-3.2.1 Light-duty Fitting Details

The light-duty fitting consists of a track stud, a shear block, a knurled nut, a flat washer, and a Prevailing Torque Type Locknut (IFI 100, Grade C). The light-duty fitting has a rated nominal working load of 75 lbs. (50 lbs. shear) for deck mounted installations and 40 lbs. (shear) when used on the bulkhead. It should be noted that the light-duty fitting design results in shear loads being transmitted directly to the stud.

The maximum dynamic load allowable for a light-duty fitting shall not exceed the "Tested Proof Load" shown in Tables 1-1 through 1-4 for that fitting. These loads shall be determined from a DDAM analysis of the mounted equipment and foundations using NAVSEA 0908-LP-000-3010, Rev. 1, "Shock Design Equipment for Surface Ships", assuming a rigid deck or bulkhead (see Chapter 6).

To install a light-duty fitting into any SMART track, place the stud in the track with the anti-rotation bosses aligned with the center of the track and the center of the stud aligned between a pair of track cantilevers. Place the shear block over the stud with the shear block bosses engaging the track cantilevers. Install the knurled nut on the stud above the shear block and hand tighten it against the shear block. Use pliers to tighten the knurled nut an additional 1/4 turn. A foundation or piece of equipment may now be attached to the stud using the Prevailing Torque Type Locknut (IFI 100, Grade C) and the flat washer provided with the fitting.

Note:

Proper installation torques are essential to the performance of the SMART System fittings. Tighten the Prevailing Torque Type Locknut to 55 ft-lbs (dry torque) (see Figure 1-6).

3-3.2.2 Medium-duty Fitting Details

The medium-duty fitting consists of two track studs, two flat washers (for the studs), two Prevailing Torque Type Locknuts (IFI 100, Grade C); a high strength steel fitting block; and a 5/8" diameter SAE Grade 8 foundation mounting bolt with a flat washer.

The maximum dynamic load allowable for a medium-duty fitting shall not exceed the "Tested Proof Load" shown in Table 1-1, Table 1-2, Table 1-3, and Table 1-4 for that fitting. These loads shall be determined from a DDAM analysis of the mounted equipment and foundations using NAVSEA 0908-LP-000-3010, Rev. 1, "Shock Design Equipment for Surface Ships", assuming a rigid deck or bulkhead (see Chapter 6).

Nominal load capacity for the medium-duty fitting is 175 lbs. in tension or shear. The bottom of the medium-duty fitting is recessed in the area of the track cantilevers to provide free space for the track cantilevers to flex. This allows the track cantilevers as well as the stud to be pre-stressed when the track stud nut is torqued. The medium-duty fitting is thus forced down onto the shoulders of the track with a calibrated preload.

The medium-duty fitting is designed with shear bosses at both the track and the foundation mounting surfaces of the fitting. The shear bosses take all shear loads. The studs, which attach the fitting to the track, and the bolt, which attaches the foundation to the fitting, are only in tension. The shear boss at the foundation mounting surface of the fitting is 1 ¼" diameter by 3/16" high. The foundation should be designed with a 1 5/16" clear hole to mate with the shear boss. The foundation bolt length provided is sized to accommodate a foundation flange thickness of ¼". For thicker foundations the bolt lengths must be adjusted to suit.

The medium-duty fitting can not be used with type "C" track. To install a medium-duty fitting into type "S", "M" or "A" track place two studs 2" apart in the track with the anti-rotation bosses aligned with the center of the track and the center of the studs aligned between a pair of track cantilevers. Place the fitting block over the studs with the shear bosses engaging the track cantilevers. Install a Prevailing Torque Type Locknut (IFI 100, Grade C) and a flat washer on each stud.

Note:

Proper installation torques are essential to the performance of the SMART System fittings. Tighten both Prevailing Torque Type Locknuts to 55 ft-lbs (dry torque). A foundation or piece of equipment may now be attached to the fitting using the 5/8" diameter SAE Grade 8 foundation mounting bolt and the flat washer provided with the fitting.

Thread locking compound (MIL-S-46163, Type II, Grade N) is required when installing the 5/8" diameter foundation-mounting bolt that fastens the foundation or equipment to the medium-duty fitting.

Note:

Proper installation torques are essential the performance of the SMART System fittings. The installation torque for the 5/8" diameter medium-duty foundation mounting bolt with the thread-locking compound is to be 129 ft/lbs (see Figure Figure 2-1, Figure 2-2, Figure 3-6, and Figure 3-7).

3-3.2.3 Heavy-duty Fitting Details

The heavy-duty fitting consists of two medium-duty fittings (with associated hardware), a high strength steel fitting block; and a 3/4" diameter SAE Grade 8 foundation mounting bolt with a flat washer.

The maximum dynamic load allowable for a heavy-duty fitting shall not exceed the "Tested Proof Load" shown in Table 1-1, Table 1-2, Table 1-3, and Table 1-4 for that fitting. These loads shall be determined from a DDAM analysis of the mounted equipment and foundations using NAVSEA 0908-LP-000-3010, Rev. 1, "Shock Design Equipment for Surface Ships", assuming a rigid deck or bulkhead (see Chapter 6).

Nominal load capacity for the heavy-duty fitting is 350 lbs. in tension or shear. The bottom of the heavy-duty fitting is recessed to mate with the shear bosses on the medium-duty fittings. The heavy-duty fitting is designed with a 1 ¼” diameter by 3/16” high shear boss at the foundation mounting surface of the fitting. The shear boss transmits all shear loads between the equipment foundation and the fittings. The bolts that attach the heavy-duty fitting to the two medium-duty fittings and the bolt that attaches the foundation to the fitting are only in tension. The foundation should be designed with a 1 5/16” clear hole to mate with the shear boss. The foundation bolt length provided is sized to accommodate a foundation flange thickness of ¼”. For thicker foundations the bolt lengths must be adjusted to suit.

The heavy-duty fitting can not be used with type "C" track. To install a heavy-duty fitting into type “S”, “M” or “A” track install two medium-duty fittings 5” apart (center to center) in the track. Place the heavy-duty fitting block over the medium-duty fittings shear bosses and fasten with the two 5/8” diameter SAE Grade 8 bolts.

Thread locking compound (MIL-S-46163, Type II, Grade N) is required when installing the two 5/8” diameter bolts that fasten the heavy-duty fitting to the two medium-duty fittings.

Note:

Proper installation torque’s are essential to the performance of the SMART System fittings. The installation torque for the two 5/8” diameter mounting bolts with the thread-locking compound is to be 129 ft/lbs.

A foundation or piece of equipment may now be attached to the heavy-duty fitting using the ¾” diameter SAE Grade 8 foundation mounting bolt and the flat washer provided with the fitting. Thread locking compound (MIL-S-46163, Type II, Grade N) is required when installing the ¾” diameter foundation-mounting bolts that fasten the heavy-duty fitting to the two medium-duty fittings.

Note:

Proper installation torque’s are essential to the performance of the SMART System fittings. The installation torque for the ¾” diameter foundation mounting bolt with the thread-locking compound is to be 307 ft/lbs (see Figure 2-3, Figure 2-4, and Figure 2-5).

3-3.3 Basic Function of Equipment Foundations

Equipment that is installed in a SMART space that isn’t designed specifically for use with the track system fitting shall require an equipment foundation. Equipment foundations designed for use with medium or heavy-duty fittings shall be designed to effectively utilize the shear bosses located on the top of the fittings (see paragraph 3-3.2).

3-4 System Load Limits

3-4.1 Load Population Density

The foundation track system is designed to permit equipment to be mounted in close proximity to each other. The locations of equipment shall be such that the working load of the track system does not exceed 600 lbs./ft for all types of deck or bulkhead foundation track.

3-4.2 Weight Limitations (Equipment Installation)

The maximum weight of a piece of equipment that should be installed on a minimum of four heavy-duty fitting assemblies, due to the design of the fittings, is 1,690 lbs. when upper foundations are used. The maximum design unbraced weight is 617 lbs. In order to provide a safety margin the recommended maximum nominal load (braced) supported by four heavy-duty fittings is 1400 lbs. The unbraced safe load must be determined by calculation so as not to exceed the fitting design working loads.

3-5 Criteria for Selection of Foundation Track System

3-5.1 Foundation Track System Installation Considerations

The following factors shall be evaluated to determine the best approach for selection of foundation track system by the design activity.

3-5.1.1 Deck Fairness Impact

The fairness of the deck is of prime concern to the designer when planning to install the foundation track system directly on the deck . The deck may only have a maximum unfairness of 3/16", using a ½" square wood batten. For larger gaps between the track and deck, the deck shall be straightened to provide a more fair surface or side plates shall be used and scribed to attach the track to the deck. The design agent need not be concerned with deck fairness when the track system is installed on a false deck substructure. The false deck substructure will compensate for any unfairness in the deck (see Chapter 5). The attempt to install track directly on the deck in an overhaul/backfit situation will lead to difficulties because of the unfairness problem. Direct deck installation will proceed much more smoothly during the new construction event at a "flat panel" production area.

3-5.1.2 Overhead Requirements

The design activity shall evaluate the deck to overhead requirements. The heavy-duty fitting will add an additional height of 1.375" not including foundation and track profile selected. The design activity shall determine subfoundation height and adjust for track and fittings. For decks with shear and/or camber, it is recommended to establish a flat plane for the SMART Track installation. The determination of this plane requires a rigorous study of overhead clearances and space arrangements, and may result in a substructure of varying heights to account for shear, camber and deck unfairness.

3-5.1.3 Track Orientation

When installed directly on the deck the track system can be installed transversely or longitudinally at the discretion of the designer. Track installed on a raised deck works best if it is installed at right angles to the existing deck stiffeners so as to allow the subfoundation to rest across the existing structure. When installing new substructures over existing deck structures point crossings (“knife edges”) shall be avoided by the installation of chocks or other structures (see Figure 1-1).

3-5.1.4 Choice of SMART Track Type

The choice of track is dependent on the mission role of the space where track is being installed. Spaces which require the installation of relatively heavy equipment items (i.e. electronic equipment racks) which must meet Grade A shock requirements type “S”, “M” or “A” track is required. Spaces that are populated with staff and personal computers, which would generally require only light-duty fittings, may have the light weight type "C" track installed.

The maximum allowable point load for type “S”, “M” and “A” foundation track is 350 lbs when using a heavy-duty fitting. The maximum allowable point load for type "C" foundation track is 75 lbs (50 lbs. in shear for deck mounted installations and 40 lbs. in shear for bulkhead mounted installations) when using a light-duty fitting (medium and heavy-duty fittings can not be used with type “C” track).

Type “S” and “M” foundation tracks are intended for welded installation on ships with steel structure. When deciding between type “S” (high strength steel) or type “M” (mild steel) consideration should be given to the trade off between the higher cost of type “S” track versus the higher weight of type “M” track. The type “A” foundation track is intended for welded installation on ships with aluminum structure.

Because the type “C” light weight foundation track must be bolted to a structurally sound false deck substructure, it can be installed on either steel or aluminum structure.

3-5.2 Existing Ships Systems Impact

3-5.2.1 Existing Cableways

The subfoundation frame will have an impact on the under deck cableways. The frame structure will restrict the cableway to the opening between the struts. Design and installation of the modular foundation track system shall take into consideration existing and future cable trunks and wireways. Existing wireways shall not be relocated unless deemed absolutely necessary by the design agent. False deck installation shall provide cutouts in the subfoundation for cable runs under the deck. Vertical cableways shall be taken into consideration. Care shall be taken to maintain adequate access (see Figure 1-1).

3-5.2.2 HVAC (Impact)

Non-structural HVAC ducts or trunks shall not have track or a subfoundation attached to the duct or trunk. The subfoundation or track shall not be placed in direct contact with non-structural units. A structural frame and/or deck support and edging shall be provided to retain/bound the deck tiles, and prevent casual water or spills from wetting or penetrating beneath the false deck.

3-6 Naval Ship Overhaul Installation Design Criteria

3-6.1 SMART Shipcheck

The first step in determining the selection of a deck foundation track system begins with a thorough shipcheck of the space proposed to have the track system installed as well as the contiguous spaces. The main objectives of the shipcheck are to determine and confirm the structural configuration of the deck and bulkheads, and to perform a structural survey as well as note the overhead clearance and locations of cableways duct work, piping, and deck penetrations.

3-6.1.1 Structural Configuration

One of the objectives of the shipcheck is to confirm the structural configuration of the deck and bulkheads where the SMART foundation track system is to be installed. Items that are of general importance are the locations of the under deck support structure and the locations of any equipment, foundations, cableways, ductwork, or piping in the overhead of the space below that may need to be moved or worked around in order to straighten the deck, if necessary. The structure in the surrounding spaces shall be confirmed for the track substructure as required.

3-6.1.2 Deck Survey

3-6.1.2.1 Deck Fairness

From the inspection of the proposed SMART space, the main determining factor of what type of installation substructure will be installed (true deck or false deck) is the overhead clearance. For spaces that have enough clearance to support a false deck installation, regardless of how low, the false deck substructure is recommended. Otherwise, a true deck installation is necessary. The true deck installation requires an extensive deck survey to determine the deck fairness. The maximum unfairness permitted for a true deck installation is 3/16" using a 1/2" square wood batten. If the deck is out of tolerance, it needs to be straightened by either bumping and/or jacking to provide a flat surface on which to install the track.

3-6.1.2.2 Shear and Camber

It is always advisable to install the SMART track system in such a way that the finished deck will be absolutely flat. In this way, all future foundations will not require shimming regardless of their location within the space. The presence of a false deck responds to the flatness requirement and also provides a space for cable runs and allows for maximum ease of future equipment relocations. In a space where the deck has a shear and/or camber, it becomes necessary to select a plane, parallel to the horizontal base plane of the ship at which to install the new deck. The overall clear headroom present in the space usually governs the height of this plane. In spaces where the structural deck has severe shear or camber, the SMART deck may be stepped to take maximum advantage of the usable headroom. Installation jigs have been designed to aid the installer in achieving critical alignment tolerances (see Figure 2-11).

3-6.2 Equipment Installation Requirements

3-6.2.1 Equipment Loading Requirements

Equipment planned for installation in the SMART space has a direct bearing on the type of track chosen (see paragraph 3-5.1.4). Equipment may be designed and engineered to work directly with the track systems. Other equipment items shall be evaluated for weight. Equipment with weight densities less than 75 lbs. per square foot (50 lbs shear when deck mounted, 40 lbs shear on bulkhead installations) may be installed on type "C" track. Equipment with weight densities exceeding 75 lbs. per square foot shall have type “S”, “M” or type “A” track installed. In addition, foundations may be designed for heavy equipment to spread the footprint out and reduce the weight density that the track must restrain (see Figure 2-10).

3-6.2.2 Future Loading

Equipment items that are planned for future installations shall be taken into consideration when choosing a track system. Features such as overall dimensions, weight, cable accesses, etc., should be evaluated and considered when determining a track system design.

3-6.2.3 Overhead Obstructions Requirements

The preferred method of track installation is on a structural false deck. This eliminates the process of fairing the deck. The deck substructure is capable of compensating for an unfair deck. The height of the overhead in the proposed SMART space has a direct bearing on the choice of a true deck or the height of a false deck installation. The false deck track system shall be installed so as to keep at least minimum acceptable overhead clearance in the space. A low profile subfoundation is the recommended approach for a restricted height true deck installation rather than shrinking or bumping and jacking to straighten the deck. The low profile substructure is not considered a true false deck since it has minimal space for cables (see Chapter 5).

3-6.2.4 Cabling Requirements

The locations of cable trunks and wireways have an impact on the type of track system installed in a space. Where practical, existing cable trunks and wireways should be preserved unless the overhaul will remove all or most of the cables in the cableway. The designer shall take future wireways into consideration when selecting a method of installing a foundation track system.

3-6.2.5 HVAC Requirements

Where practical, the locations of HVAC ductwork shall be preserved. Future ducting, if known, shall be taken into consideration when selecting a method of installing a foundation track system.

3-6.3 Ship’s Deck Structural Analysis

A DDAM analysis (NAVSEA 0908-LP-000-3010, Rev. 1 "Shock Design Criteria for Surface Ships") is required to be performed on the SMART Track support substructure and equipment foundations, taking into account the centers of gravity and weights of the proposed equipment (see Chapter 6). The fitting loads resulting from the DDAM calculation must be verified to be below the pull test proof results of the specific type of track/fitting (see Table 1-4, Table 1-3, Table 1-1, and Table 1-2) being proposed for use. In addition, combined loading should also be addressed in accordance with paragraph 6-7 and Figure 3-6 and Figure 3-7.

3-6.4 Selection of Deck Foundation Track System

The designer shall select the appropriate track system based on the requirements of paragraphs 3-5.1.4 ; 3-6.1 ; 3-6.2 ; and 3-6.3 . The designer shall then design all supporting structures for this selected system.

3-7 New Construction Design Criteria – Metric Dimensioning

The ISO 9000 and future design specifications for ship building of new US Naval ships restrict the design to metric dimensioning, which will have an impact on the current SMART foundation system and components. The SMART system is designed and engineered to SAE standards, and it is applicable in all aspects, with the exception of metric dimensioning. The SMART track profile originates from an existing ISO standard (ISO 7166), which is used worldwide by the aircraft industry (see paragraph 3-7.1). The industrial agent's metric conversion and any changes to track spacing will affect the current certification of the track, and installation of SMART components as specified in this document. It is recommended that the SMART deck foundation system be installed as designed. Any design changes will require re-certification.

3-7.1 Metric Impact

New ship construction may adopt the installation design requirement for the foundation track as stated in this document to retain shock qualification with the track referred to as "soft metric" (English) using the SAE hardware. Deviation from the standard spacing will affect the mechanical form, fit, and function of the track and deck components, with equipment designed to fit the system, and with the load limitations of the track and fittings.

3-7.1.1 International Standards

The International Organization for Standardization (ISO 7166), Aircraft Rail and Stud Configuration for Passenger Equipment and Cargo Restraint established the 1-inch pitch for the track.

3-7.1.2 Metric Track Design

The Type "C" track is the only accepted COTS track suitable for use on US Naval ships. Currently there are no metric COTS tracks or fittings available. The Types "S", "M" and "A" track may be engineered into metric standards; however, the track pitch of 1 inch on center shall be retained to be in compliance with ISO 7166 and this document.

3-7.1.3 Alternative Designs

The most efficient method of track installation for a conventional overhaul is the structural false deck creating a structurally sound and flat mounting surface within the track's tolerance specification (see paragraph 4-4.2.2). This increased weight of a structural false deck may be minimized during new construction. An alternative is to design the SMART spaces with the deck plating on the underside of the stringer and to design cable penetrations into the structure. This will create a false deck subfoundation with a smooth overhead in the compartment below. The space below may be engineered for overhead track. Stacking SMART spaces provides a flat structural overhead an advantage for future development and modular HVAC.

3-7.1.4 Supporting Modular Components

Equipment may be designed and manufactured to be compatible with ISO 7166 and track spacing of 12 inches on center. New equipment with base frame mounting holes spaced incrementally at one inch intervals will fit directly into any SMART track installation and provide the capability of locating the equipment in one-inch increments anywhere on the SMART deck without the need for a foundation. Any deviation of equipment configuration becomes the responsibility of the industrial agent for form, fit and function with the system. One of the products of the MIWG is a set of workstations and tables as well as power distribution and lighting equipment designed to fit and be used with the SMART Track system. These components are described in Volume II of this manual.

3-8 Test Facility Site Design Criteria

Test facilities or training facilities provide ideal applications for SMART deck foundation track and components. Those facilities with SMART track can receive equipment with minimal impact. The C4I command's suite laboratories or test facilities can be rapidly changed to accept the changing technology and new equipment, (see Chapter 2). The track and deck system on the ship will exactly match the track and deck system in the test facility.

3-8.1 Land Based Test Site Load Requirements

Land based test sites will not be required to meet the dynamic shock load requirement as aboard US Naval ships. The facility's design activity shall design to local codes and static loads of the SMART foundation track, components and equipment as applicable. For most land-based facilities, Type "C" foundation track bolted at 6 inches on center will be acceptable. This installation will provide geometric similarity to the ship installation at a more modest cost.

3-8.2 Turnkey Application

The land based test facility's SMART foundation track installation provides an ideal platform for a turnkey application. The turnkey approach utilizes the land-based facility to configure and duplicate a shipboard equipment suite with fixed hard foundations. The equipment is laid out as aboard the ship with all interconnecting cabling installed. The equipment can be checked out and tested, cabling can be cut and connectors attached (per shipboard cableway layout) and foundations can be prefabricated. The designer can turn the system over to the ship, pre-packaged and tested, for direct installation.

3-8.3 SMART Track and Substructure Installation Data Plates

Data Plates shall be provided at the entry to the facility's SMART space. The Data Plate shall identify the foundation track's maximum point loading and population density in accordance with paragraph 4.5 (see Figure 3-8).

SMART TRACK DECK LOAD LIMITS

DECK:

A. TRACK ARRANGEMENT: (TRANSVERSE OR LONGITUDINAL)
B. BAY: (DESCRIBE THE DESIGN BAY GEOMETRY)
C. TRACK TYPE S (HSLA 80), M (OS STEEL), A (ALUM), C (COTS)
D. LOAD DENSITY: (LBS/FT FOR XX FT FOR A BAY)
E. LARGEST FITTING TO USE WITH TRACK:
F. EQUIPMENT POPULATION DENSITY: (# OF FIXED LOADS FOR A BAY)
G. INSTALLATION DWG NUMBER FOR THIS SPACE: (DWG #)
H. DESIGN DATA PACKAGE FOR THIS SPACE: (DWG #)

WARNING: DO NOT EXCEED XXX LBS/SQ.FT. DO NOT WAX DECK TILE OR CLEAN WITH OIL BASED DETERGENT, POLISH, OR WAX, USE ONLY A DAMP MOP.

SMART TRACK BULKHEAD LOAD LIMITS

BULKHEAD:

A. TRACK ARRANGEMENT: (VERTICAL OR HORIZONTAL AND SPACING)
B. BAY: (DESCRIBE THE DESIGN BAY GEOMETRY)
C. TRACK TYPE S (HSLA 80), M (OS STEEL), A (ALUM), C (COTS)
D. LOAD DENSITY: (LBS/FT FOR XX FT FOR A BAY)
E. LARGEST FITTING TO USE WITH TRACK:

WARNING: DO NOT INSTALL EQUIPMENT IN EXCESS OF XXX LBS/LF OF TRACK
REF: SEE NAVSEA TECHNICAL MANUAL S6468-AA-INM-010 FOR GUIDANCE

Figure 3-8 Label Plate Format

Chapter 4
Engineering Design Procedures

4-1 Introduction

This chapter provides the engineering procedures for the design engineer to determine the foundation deck track loading requirements and population density based upon the track type and ship's existing support structure. The engineer shall design and rate the SMART space's overall load bearing capabilities for the deck foundation track. Any deviations to the deck loading maximum for the track foundation system shall be defined as stated in this chapter. The bulkhead foundation track requirements and limits are defined in paragraph 4-4 .

4-2 SMART Track System Designed Rating

4-2.1 Track System Load Rating

The foundation track systems are designed for maximum loading. The Type "S", "M" and "A" track system is designed to support a maximum dynamic point load of 25,000 lbs. in tension (vertical direction). The Type "C" track system can support a maximum dynamic point load of 6,250 lbs. in tension (vertical direction). These loads can be applied at any position along the tracks that a fitting can be installed.

A "DESIGN BAY" is usually defined as a pair of parallel tracks spanning across the entire space in which they are installed. "LOAD DENSITY" is defined as the maximum unit load, which may be applied at any position along the bay. These loads are usually associated with a specific piece of equipment, and therefore a linear dimension along the track will also be known. An example of a load density would be "1000 lbs. in 3 ft.".

4-2.2 Overall SMART Track Foundation System Rating

The overall deck/track foundation system rating is dependent on the deck that the track system is installed on. Maximum rating can be achieved for each type of track system. The track systems may be downgraded from the maximum rating if the deck is not capable of supporting the maximum loading. The design agent shall, where feasible, design the supporting systems (ship structure and track substructure) to take advantage of the maximum safe load of the foundation track system, designing the entire space to support the maximum load that the track can handle. However, where the ship structure will only support a portion of the track maximum, and the load requirements also fall below the maximum, the SMART space and its track system may be de-rated for the lesser load, and labeled. (See paragraph 4-5)

4-2.3 Population Density Rating

"POPULATION DENSITY" shall be defined as the maximum number of applications of the load density along any single design bay. For example, a design agent may set the substructure transversely and define two parallel tracks to be a design bay for the space. The population density and structural framing direction for each space shall be determined by the design activity, and stated on the label plate with warnings for any area rated for other than maximum design capacity of the track type. As an example, the engineer could define the load density to be 1200 lbs. in 4 ft., with a maximum population density of two. This would mean that two 1200 lb. foundations, each of which is 4 ft. long could be placed in any arrangement along any two tracks in that space.

In another example, a design agent may be installing SMART Track in a space where only computer terminals will be installed. The load density may be only 300 lbs. in 4 ft. In this case, the population density could go as high as 7 for a 30-ft. wide space, providing the proper structural reinforcements had been made. The data plate which would guide future rearrangements of the space would define the design bay and give the load density and population density for that bay. With the information on the data plate, future engineers and designers could safely rearrange and reuse the space. They could prepare a new arrangement, design and prefabricate all necessary foundations and order new equipment and SMART fittings without even visiting the ship. The installation could be accomplished rapidly when the ship returned to port. No hot work, ripout, deck resurfacing, or disruption of adjacent spaces would be required (see Figure Figure 3-8).

4-3 SMART Track System Installation Design Procedure - Decks

4-3.1 Loading Requirements

The design agent shall be responsible for estimating the loads to be carried by a planned SMART Track system. The weight of the equipment to be installed and parent ship structure shall determine the type of track that should be installed.

4-3.2 Selection of SMART Track Type

For SMART track selection guidance see Chapter 1.

4-3.3 SMART Track Structural Support Design

4-3.3.1 True Deck Support Design

In the true deck installation, the foundation track is installed directly on the deck. The design activity shall be responsible for determining the maximum equipment load carrying capacity of the deck. The loads on the deck and track shall be determined by performing a DDAM analysis using NAVSEA 0908-LP-000-3010, Rev. 1 “Shock Design Criteria For Surface Ships”. The deck shall be reinforced if necessary to support the weight of the equipment to be installed.

4-3.3.2 SMART Track Support Substructure Design

The substructure, whether it is installed above or below the ships deck, shall be engineered by the design activity to support the maximum load in the SMART space (see Chapter 5).

4-4 SMART Track Installation Design Procedures - Bulkhead

4-4.1 Selection of Bulkhead SMART Track Type

Any of the track types can be used, however only light-duty fittings are allowed when using type “C” tracks because the medium and heavy-duty fitting preloads will distort the type “C” track. The light-duty fitting, when used on bulkhead track, is only rated for 40 lbs. vice 75 lbs. (50 lbs. in shear for deck mounted configurations) because vertical shock loads must be taken directly in shear when the light-duty fittings are used on bulkheads. To reduce the number of fittings required, medium or heavy-duty fittings are also appropriate for bulkhead applications when using type “S”, “M” or “A” track.

4-4.1.1 Track Directional Layout Requirements

The bulkhead track shall be installed either vertically or horizontally according to the design activity. The designer should avoid placing SMART Track on any bulkhead/deck that behaves as hull structure as illustrated in Figure 3-4 of NAVSEA 0908-LP-000-3010, Rev. 1. However, when SMART Track must be placed on bulkheads/decks that behave as hull structure, half shall reduce all static design capacities. The system has a “deck” shock rating. Bulkhead track is recommended to be installed on 24" centers. A 24" installation jig shall be provided for bulkhead installation. It is recommended that the vertical bulkhead track begin 30" above the finished deck and extend vertically for 60". In the horizontal configuration, it is recommended that the first band of track begin a minimum of 12" up to 30" above the finished deck with 24" spacing for a total of three bands installed.

4-4.2 Hull Structural Configuration

4-4.2.1 Structural Support Design

The bulkhead foundation track may be installed on the bulkhead structure spaced at 24" on center. The Types “S”, “M” and “A” bulkhead foundation track shall be welded to the bulkheads or to the bulkhead supports. A bulkhead substructure made of tee’s shall be installed horizontally if the ship’s existing bulkhead supports are not 24" on center. Bulkheads that do not have supports on them, such as “dimpled” bulkhead, shall have substructure installed to accept the track if necessary. The Type “C” track system may be bolted to a substructure installed on the bulkheads either on the existing stiffeners or a subfoundation welded perpendicular to the stiffeners. The bulkhead substructure for Type “C” track shall be constructed from angle to allow easy installation of the bolts.

Where track is needed on the flat side of the bulkhead, the track may be welded directly to the bulkhead surface as long as a stiffener backs it up on the other side. The design activity shall be responsible for selecting a substructure capable of supporting the bulkhead-mounted track, foundations and equipment.

4-4.2.2 Tolerance Requirements

Due to the design of the equipment bulkhead foundations, having the tracks parallel and in pitch is more important than maintaining plane tolerances similar to the deck installation. As long as the bulkhead plane is within ± .250" in 10 feet, power panels and other bulkhead mounted equipment may be leveled with washers or spacers. The end spacing of the track joints shall be maintained by the use of the bulkhead track installation jig. In any case, track spacing, parallelism and pitch shall be maintained at plus or minus.005" track to track with a maximum of .020" in 10 feet.

4-4.2.3 Installation Fastening Method

Installation of bulkhead track shall be similar to foundation deck track. The Types “S”, “M” and “A” track shall be welded along its length to the bulkhead stiffeners or to the subfoundation. The Type “C” track shall be bolted to a subfoundation every 2" using SAE grade 8 3/8-16 countersunk flat head machine screws.

4-5 Documentation

4-5.1 Data Plates

A Data Plate shall be affixed to the bulkhead, near the door, in each space where a SMART Track mounting system is installed. The data plates shall be in accordance with MIL-P-15024, Type F, Style II (laminated plastic black background with white characters). Label plates shall be affixed using pressure sensitive tape in accordance with MIL-T-60394. The label plates shall be maintained at all times, and shall not be removed or covered, nor restricted from sight upon entering a space. An additional area of 100-sq. in. below the label plate shall be maintained for posting of additional information or design changes. The data plate shall have a separate section for each mounting system, as many as six (deck, overhead, and four bulkheads). See Figure Figure 3-8 for a sample of a data plate for a compartment with a deck system and a bulkhead system on the FWD bulkhead. For each mounting system, the data plate shall provide the following information:

a. Track Arrangement

b. Bay Definition

c. Track Type

d. Load Density

e. Largest Fitting Type Allowed

f. Population Density

g. Installation Drawing Numbers

h. Design Data Package Numbers

Warnings as needed. This is where the Designer would be warned to reduce the design capacity of the fittings when the SMART Track must be used on bulkheads that act as hull structure.

In addition, there will be reference at the bottom of the plate to this Design Manual.

4-5.2 Caution Plates

Caution plates with information concerning irregularities of the track system such as “soft patches” installed in the SMART spaces shall be displayed in proximity to the area of concern.

4-5.3 Ship's Information Book

Volume 1 of the Ship's Information Book (SIB) shall be updated to describe the existence of any SMART installations and reference to associated documentation.

Chapter 5
SMART Track Substructure

5-1 Introduction

This chapter provides design guidance on the structural support design for a flat subfoundation structure on which to install the foundation track system and deck tile. Flatness within a SMART space is essential; however, levelness may be within 1/4" in 10 feet.

The three approaches to providing a flat surface for installation of foundation track are a true deck with under deck structure; a false deck, and a low profile subfoundation.

The low profile is not intended to be used as a false deck. It is used to provide a method to install bolted or welded track within a space with minimum height and to reduce the cost of deck shrinking, bumping and jacking or for avoiding impact to under deck spaces. The low profile subfoundation consists of angular structural members for bolted track and low structural tee's for welded track. The structural subfoundation design shall be determined by the design activity.

5-2 Subfoundation Structural System Design

5-2.1 Subfoundation Mechanics

The subfoundation is a structural extension of the true deck in a SMART space. It is used where a raised deck is desired. The subfoundation shall be welded to the deck providing a shock capable mounting surface within ±1/16" flatness and level to within 1/4" in 10 feet for track installation. The subfoundation track supports shall be parallel within ±1/8 inch and spaced at 12 inches on center. Normally, a false deck would be installed parallel to the horizontal base plane of the ship but this is not required. Where a deck has extreme camber and/or shear, the SMART deck could be installed with a slope greater than 1/4" in 10 feet. This would require that all foundations be shimmed to level. Another option for a deck with extreme camber and/or shear is to construct the SMART deck in one or more level steps.

5-2.2 Subfoundation Design for Type "S", "M" and "A" Track

The substructure for Type "S", "M" and "A" track are fundamentally the same, except for the material. The substructure shall be sound aluminum or steel members suitable for welding, and shall be within the design loads of the track system.

The subfoundation shall be designed to be carried by the deck structure (see Figure 2-6). The top flange of the subfoundation shall be wide enough to support the track, welds, deck tile, and deck tile spacers. The deck tile shall be supported a minimum of 1/2 inch all around. The flange may be designed to support the 1-inch wide spacers. The design agent shall provide cross members or intercostals to support the deck tile ends and shall integrate the intercostals into the substructure. The intercostals shall be placed to coincide with the deck tile layout (see paragraph 7-2.1). The substructure shall be designed for maximum cable and terminal box access.

5-2.3 Subfoundation Design for Type "C" Track

A subfoundation is required for the installation of Type "C" foundation track. The Type "C" track system shall be bolted to the subfoundation using a 3/8-16 UNC flat head, fully threaded, countersunk SAE grade 8 machine screw with a matching self-locking nut and flat washer. The bolts shall be placed every 2" on center and dry torqued to 55 ft-lbs. Type "C" track installation requiring a low profile shall use angle for the subfoundation with a 1 1/2" minimum height clearance at the deck highest tangent point to allow for hardware mounting.

5-2.3.1 Adjustable Subfoundation Support System

An adjustable subfoundation is one type of Type "C" subfoundation. The adjustable subfoundation consists of channels and intercostals that are bolted together and are supported by threaded columns, spaced 24" apart, that are adjustable to provide a level mounting surface. The channels are spaced such that the track maintains the 12" on center. spacing (see Figure 5-1).

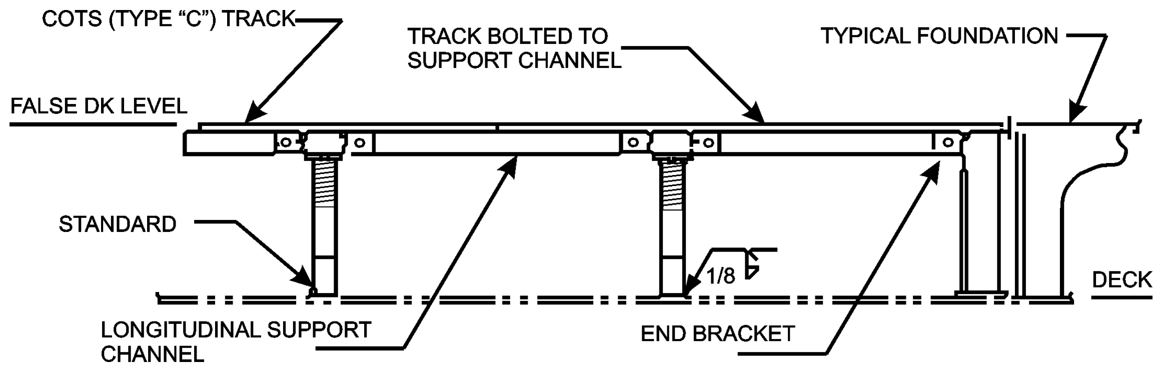


Figure 5-1 Example of a Hard Foundation through COTS Track

5-3 Shock Qualification Analysis

5-3.1 Deck Mounted Track

An appropriate NAVSEA 0908-LP-000-3010, Rev, 1 "Shock Design Criteria for Surface Ships" DDAM analysis is required to be performed on the entire deck structure subfoundation supporting the SMART Track system. In cases where large compartments are involved, it may prove advantageous to model the deck structure out to the first structural bulkhead, and apply hull inputs into the entire system rather than modeling the subfoundation with its fixed base at the deck.

The subfoundation/deck structure shall be designed using elastic inputs and the allowable stress shall be in accordance with the limits of Non-Alignment Sensitive Equipment and Foundations.

5-3.2 Bulkhead Mounted Track

An appropriate NAVSEA 0908-LP-000-3010, Rev, 1 "Shock Design Criteria for Surface Ships" DDAM analysis is required to be performed on the entire bulkhead substructure supporting the SMART Track system. The designer should avoid placing SMART Track on bulkheads that behave like hull structure as defined in the document above. However, on such occasions as the designer finds it must be done, the designer shall use hull inputs vice deck inputs in analyzing the substructure.

The substructure shall be designed using elastic inputs and the allowable stress shall be in accordance with the limits for Non-Alignment Sensitive Equipment and Foundations.

Chapter 6
Modular Equipment Foundation Designs

6-1 Introduction

This chapter defines and provides design guidance to develop modular equipment foundations to meet each installation requirement. The design agent shall design all necessary foundations to support equipment and attach it to the SMART Track system. Care shall be taken not to exceed the load density capacity of the track design.

6-2 Equipment Foundation Design

For most applications the engineering agent will be required to design an equipment foundation to mate with an equipment rack or console that is not directly compatible with the foundation track. The foundation shall be designed, for example, to interface with a specific rack's or console's footprint and the track's one-inch pitch and 12" spacing.

Flat plate foundations should be avoided for all but the lightest equipment. Flat plate foundations with multiple fittings at the covers should be avoided completely. Analysis of this type of foundation indicates excessive flexure of the flat plate under dynamic loads, resulting in progressive failure of the SMART fittings. For small lightweight equipment, very small flat plate foundations with single fittings at the corners work best. The design securing hardware to be used with the light-duty fitting is supplied with the fitting (see paragraph 2-2.1).

The foundations for use with Type "S", "M" and "A" foundation track which requires medium or heavy-duty fittings for installation shall be designed with a 1.250" mating hole in the bottom flange of the foundation. The intent is for the fitting's boss to carry the shear loads, and for the bolt to merely "hold down" or clamp the foundation flange to the fitting. A large washer or plate shall be designed to work in conjunction with the bolt. In no instance shall the foundation bottom plate be thinner than the fitting's boss (3/16″ high), which would result in the bolt bottoming out on the boss and failing to clamp the foundation to the fitting. The goal is to use the bolt to clamp the foundation into place, and to use the shear boss to isolate the bolt from shear and bending loads, limiting the bolts and studs to a purely tensile function (see Figure 3-7). It is recommended to use a 1/4″ thick foundation flange as a minimum. Bolts provided with the medium and heavy-duty fittings are long enough to support foundation flanges from 1/4″ to 5/16″ thick. If thicker flanges are used, bolt lengths must be increased accordingly to maintain adequate thread engagement in the SMART fitting..

6-3 Fixed or Hard Foundation Design

Occasionally, the arrangement of a C4I space calls for the installation of a massive piece of equipment, whose load density exceeds that for which the SMART Track installed in the space was designed. The solution here is cut away the track and substructure in way of the heavy equipment and install a traditional foundation in the void, attached directly to the ships deck. This will occur especially in spaces where the light type "C" track system has been installed. In a space where lightweight workstations are contemplated for most future rearrangements the type "C" track and occasional hard foundation may prove to be the most economical solution. The approach should be similar to the design shown in Figure 5-1.

6-4 Single Point Mounting Requirement

When designing foundations for type "S", "M" and "A" track, the engineer should avoid the use of multiple adjacent fittings. It is always preferable to move up to the next size fitting rather than use multiple smaller fittings. Only light-duty fittings are allowed when using type "C" tracks because the medium and heavy-duty fitting preloads will distort the type "C" track.

Flexure of the foundation will prevent proper load sharing in the multiple fitting approach and the result will be sequential overload followed by progressive failure of the fittings. The fitting selections provided with the system have been designed to match the maximum capacity of type "S", "M" and "A" track. All of the tracks have the same maximum load density of 50 lbs./in.

The medium and heavy-duty fittings are each load dividers. Each is designed to take a concentrated load and distribute it along the track in a way that guarantees not to exceed the maximum allowable load density of the track. If a designer finds him/herself needing more than one heavy-duty fitting immediately adjacent at the corner of a foundation, it is an indication that the proposed design will overload the track. An example of a proper foundation design is shown in Figure 2-10.

6-5 Standard Foundations

A foundation design for a particular piece of equipment may be included on a standard NAVSEA drawing for all future SMART installations of that equipment. These foundations could be manufactured in quantity and supplied with the equipment, or the standard foundation drawing could be made available to the installing activity. In either event, significant cost savings would be realized. The standard fitting interface, and the standard track geometry and strength will assure a perfect fit on any ship with SMART Track installed. When designing a standard foundation the substructure shall be considered to be rigid for the shock analysis.

6-6 Shock Qualification Analysis

6-6.1 Foundations on Deck Mounted Track

An appropriate NAVSEA 0908-LP-000-3010, Rev, 1 “Shock Design Criteria for Surface Ships” DDAM analysis is required to be performed on each individual equipment foundation that the SMART Track fittings are supporting, taking into consideration the weight and the center of gravity of the equipment. For proposed resiliently mounted (MIL-S-901D Class II) equipment installations utilizing the SMART Track System, the design engineer should assume that the shock isolated equipment or isolated portion of the equipment is hard mounted while completing the DDAM analysis.

When modeling the foundation for shock analysis, it is expected that the analyst will desire to model the fitting as a pinned joint. This is usually acceptable. However, when doing so, the analyst must extract the rotation at the pinned joint and apply that rotation to the rotational stiffness of the appropriate fitting found in Table 6-1, Table 6-2, and Table 6-3 to determine the moment applied to the fitting. Alternatively, the analyst may include a rotational spring of the appropriate stiffness in the model.

The results of the above DDAM calculations shall be below the proof loads determined from destructive testing of the appropriate fitting/track combination (see Table 1-1, Table 1-2, Table 1-3, and Table 1-4 and Figure 3-6 and Figure 3-7).

For all follow on installations the maximum dynamic load allowable for a SMART system fitting shall not exceed the “Tested Proof Load” shown in Table 1-1, Table 1-2, Table 1-3, and Table 1-4 for that fitting. These loads shall be determined from a DDAM analysis of the mounted equipment and foundations using NAVSEA 0908-LP-000-3010, Rev. 1, "Shock Design Equipment for Surface Ships", assuming a rigid deck or bulkhead. If the combined mass of the new proposed equipment and already existing equipment (plus respective equipment foundations) exceed the original design parameters for the bay (see Load Density and Population Density, Figure Figure 3-8), the DDAM analysis must also include the track substructure.

6-6.2 Foundations on Bulkhead Mounted Track

An appropriate NAVSEA 0908-LP-000-3010, Rev, 1 “Shock Design Criteria for Surface Ships” DDAM analysis is required to be performed on the entire bulkhead substructure supporting the SMART Track system (see Chapter 5). For proposed resiliently mounted (MIL-S-901D Class II) equipment installations utilizing the SMART Track System, the design engineer should assume that the shock isolated equipment or isolated portion of the equipment is hard mounted while completing the DDAM analysis.

An appropriate NAVSEA 0908-LP-000-3010, Rev, 1 “Shock Design Criteria for Surface Ships” DDAM analysis is required to be performed on each individual equipment foundation that the track fittings are supporting, taking into consideration the weight and the center of gravity of the equipment.

Table 6-1 Stiffness of Fitting Assembly for Shear Across the Track

TRACK MATERIAL	HSLA		ORDINARY STEEL		5456 ALUMINUM		COTS	
STIFFNESS	Lateral kips/in	Rotational kips/rad	Lateral kips/in	Rotational kips/rad	Lateral kips/in	Rotational kips/rad	Lateral kips/in	Rotational kips/rad
LIGHT DUTY FITTING	120	68	150	85	90	51	60	34
MEDIUM DUTY FITTING	333	460	570	788	300	415	N/A	N/A
HEAVY DUTY FITTING	390	698	390	698	270	483	N/A	N/A

Table 6-2 Stiffness of Fitting Assembly for Shear Along the Track

TRACK MATERIAL	HSLA		ORDINARY STEEL		5456 ALUMINUM		COTS	
STIFFNESS	Lateral kips/in	Rotational kips/rad	Lateral kips/in	Rotational kips/rad	Lateral kips/in	Rotational kips/rad	Lateral kips/in	Rotational kips/rad
LIGHT DUTY FITTING	60	23	120	46	105	40	120	46
MEDIUM DUTY FITTING	345	730	570	1206	270	571	N/A	N/A
HEAVY DUTY FITTING	675	3071	798	3631	435	1979	N/A	N/A

Table 6-3 Axial Stiffness of Fitting Assembly

TRACK MATERIAL	HSLA	ORDINARY STEEL	5456 ALUMINUM	COTS
AXIAL STIFFNESS	kips/in	kips/in	kips/in	kips/in
LIGHT DUTY FITTING	2040	630	465	540
MEDIUM DUTY FITTING	1950	555	450	N/A
HEAVY DUTY FITTING	990	510	450	N/A

6-7 Combined Loading

To assure that the track preload is not lost or that internal fitting stresses do not become excessive the following formula shall be applied whenever a SMART fitting is subjected to combined loads.

In all cases the limiting proof loads shall be those shown in Table 1-1, Table 1-2, Table 1-3, and Table 1-4 and Figure 3-6 and Figure 3-7).

$$\sqrt{\left(\frac{T}{TPL}\right)^2 + \left(\frac{S1}{SP1}\right)^2 + \left(\frac{S2}{SP2}\right)^2 + \left(\frac{M1}{MP1}\right)^2 + \left(\frac{M2}{MP2}\right)^2} < 1$$

SP1= PROOF SHEAR ALONG THE TRACK
SP2= PROOF SHEAR ACROSS THE TRACK

S1 = SHEAR ALONG THE TRACK
S2 = SHEAR ACROSS THE TRACK

T = TENSILE LOAD
TPL = TENSILE PROOF LOAD

M1 = MOMENT ALONG THE TRACK
M2 = MOMENT ACROSS THE TRACK

MP1 = PROOF MOMENT ALONG THE TRACK
MP2 = PROOF MOMENT ACROSS THE TRACK

Chapter 7
Deck Systems

7-1 Introduction

The modular shipboard deck filler system consists of a high strength, light weight, modular deck tile and a track filler strip (track cover) that is electrically safe, easy to clean, and aesthetically pleasing. The system uses the track cover to hold the deck tile in place while filling the track's throat and protecting it from dirt and spills.

When the deck cover is forced into the track, it flares, causing the top flange to flatten and preload the tile, which secures it in place (see Figure 2-6). The track cover's self-locking tabs are set into the track throat, locking the deck tile and track cover into place.

The deck filler system eliminates the need for an electrical mat and deck tile attachment hardware. The edge of the deck tiles are undercut to allow the track cover to be flush with the top of the deck panel when snapped in place. The deck tile height of 0.580" was designed to meet the smallest track profile of the Type "C" foundation track. Deck tile shims are required for the taller profiles of the Types "A" and "S" tracks (see paragraph 6-2).

7-2 Modular Deck Tile

The deck tiles are engineered and designed to support normal personnel loads, when a full size tile is installed with a minimum of ½-inch support along all edges. The tiles shall be ordered and manufactured in accordance with NAVSEA Drawing (634-6906802) "C4I Modular Deck Tile". The weight of the deck tile is approximately 3.6 lbs. each without any shims installed. The tiles with type "A" shims installed weigh 5.2 lbs. and tiles with type "S" shims installed weighs 4.0 lbs. The modular deck tiles (10.375 ± .030" wide X 23.99 + .00 - .03" long X .580 ± .030" thick) are designed to drop in place for all deck foundation track types. The bottom edges are chamfered .188" X .188" for installing with Type "S" welded foundation track (only), with a rabbet around the top surface to accept the track cover flange. The standard color of the deck tile and track cover is Wilsonart Larkspur Blue. This color is similar to that of the standard blue electric grade matting currently found on board ships. Alternate colors may be selected if the plastic laminate meets the requirements for the tile. If the color of the deck tile is changed, the color of the track cover must also be changed to match the tile.

7-2.1 Deck Tile Layout

The designer shall layout SMART space deck tile starting at the center, working toward the bulkheads. It shall be laid out in a manner to avoid pieces of 6" or less at the ends. The desired result is to use the cut portion of a tile for the opposite end. If a situation arises where both ends would require (for instance) a 14" tile piece, adjust the starting point to permit one tile to be cut in half utilizing both pieces along the same edge, and cutting a 16" piece for the opposite side. The tile layout shall determine the placement of substructure intercostals. Once the track and substructure are installed, the tile layout cannot be changed.

7-2.2 Deck Shim

The manufacturer or installer may install deck tile shims, for use with Type "S", "M" and "A" foundation track. The installing activity shall install the deck shim on site on deck tiles that have been custom cut. The shims will provide the installing activity a method for shimming the deck tile, so that the rabbeted edge will be level with the top of the foundation track surface. Type "S" track deck tile space is .144 ± .015 inches thick X 1.00 ± .030 wide, and weighs 0.09 lbs./LF. The Type "M" and "A" track deck tile shim is .500 ±.015 inches thick X 1.00 ±.030 wide, and weighs 0.32 lbs./LF. Type "S" and "A" shims shall follow the specifications of NAVSEA Drawing (634-6906803), "C4I Deck Foundation Track Cover". The deck tile shim shall be installed on the underside of the deck tile, 3/8" in from the long edge and 1/8" in from the short edge. The deck tile shall rest on no less than ½-inch of the structural lateral supports all around. The deck shims will be attached to the underside by adhesive transfer tape, 3M-scotch No. 927 or equivalent for Type "S", "M" and "A" shim. The 3/4-inch wide tape should be centered on the top surface only, then attached to the tile. The design agent's only requirement is to determine the quantity of shim material in linear feet (see Figure 2-8 and Figure 2-7).

7-2.3 Cable Penetrations

A COTS plastic grommet/plug, designed to fit into a five-inch diameter hole centered in the tile, is used to pass cables through a tile. The plug cover can be completely removed leaving only a plastic trim hole, partially opened leaving room for six or seven cables, or it can be completely closed. The 4" diameter grommet is part #FG-2/ black, (Doug Mocket & Co., Manhattan Beach, CA, 800 523-1269) or equivalent. The grommet is glued to the tile with Epocast 87005A/B epoxy, (Ciba-Geigy Corp., Los Angeles, CA, 90039) or equivalent. Larger holes may be provided, but the designer must ensure adequate tile strength. In false deck applications, it is recommended that 10% of the deck tiles be specified to have cutouts for cable penetrations.

Note:

Do not design the penetration cutout area in way of the track or supporting substructure.

The outer edges of tiles require sealing of any perimeter edges that are cut. See Volume 2 Chapter 7 for installation procedures. The deck tiles that have holes larger than 5 inches will require a chafing ring or collar and sealant to protect the cable and prevent water from mopping and spillage from penetrating the false deck. The penetration collar shall be COTS where possible or shall be designed by the installing activity as required.

7-2.4 Quantities

The quantity of modular deck tiles required will be based on the overall foundation track area. The modular deck tile will cover the entire space unlike conventional foundation areas where the false deck abuts an equipment foundation, but does not cover the foundation opening. The only portion of a SMART space not covered by tile is the exposed track. A 5% over count should be incorporated by the design agent to account for miss cuts, or damaged tiles and spacer bars.

7-2.5 Pre-installation Deck Tile

The design agent may elect to use 3/4" fire retardant plywood tiles or other suitable material to provide a working surface during the construction phase to avoid scarring or damage to the modular deck tiles during cutting, welding, and the equipment movement phase of the installation. Type “M” and “A” track installation will require a minimum of 1” thick deck filler tiles.

7-3 Foundation Track Cover

The design agent will choose from the three pre-engineered modular deck foundation track covers to be compatible with the Type “S” & “M”, “A”, or “C” foundation track selected for each installation design. The track cover may be ordered in recommended lengths of 6 feet with a maximum length of 10 feet. NAVSEA Drawing (634-6906803) controls the specification and part numbers for ordering the track cover.

7-3.1 Quantities

The modular deck track cover quantities shall include a 15% over count, to provide the ship’s force with an inventory of replacement covers.

Note:

Cracking may occur due to fatigue from the force exerted in removing the deck covers on a routine basis, normally along the top centerline. Deck track covers that are removed on a routine basis will require inspection and replacement of any cracked covers.

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